LOCOMOTIVE RUNNING REPAIRS

HITCHCOCK

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BY

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PUBLISHED BY
DEBS PUBLISHING COMPANY,
Terre Haute, Indiana.
1893.

Los Angeles
Cal.

PRESS OF MOORE & LANGEN,
TERRE HAUTE, IND.

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PREFACE.

In placing this little book before Locomotive Machinists, the writer does not wish to convey the idea that a compliance with the instructions herein given is the only road to success, but his desire is to give, in language as concise as possible, some methods of making running repairs on locomotives, which, from personal observation, he knows to have been productive of good results. And, while hoping that those who are experienced in locomotive repairs may obtain some benefit from a perusal of its pages, the book is more especially calculated to benefit Machinist Apprentices and those inexperienced in this class of work.

While a lack of time and opportunity have prevented the production of a more complete work, an endeavor has been made to bring forward a few roundhouse "kinks" and also directions for correctly performing the work usually done on locomotives while undergoing general repairs.

Believing that a book describing in detail the manner of doing the work on all classes of locomotives would be too expensive, the writer has confined himself to a description of the work to be done on what is commonly known as the eight-wheeled American locomotive, and

believes that there is enough similarity in the work on the different types of engines that a person who acquires a knowledge of the proper manner of performing the work on the class of locomotives mentioned will have no trouble about doing the required work on those of other types; and he presents this book with the feeling that should only a few be benefited by its production, his labor will not have been in vain.

L. C. Hitchcock.

INTRODUCTION.

The subject of running repairs is so broad, that in writing upon it there can be no assurance given that many new ideas will be advanced, owing to the fact that there are scarcely any repairs to be made on an engine which may not be made in several different ways, any one of which may produce good results.

It is not the intention of the writer to convey the idea that the ways he describes of doing work are the only correct ways, for it may be proved that in some instances the ways described are not the ways which will produce the best results.

"All men are prone to error," and I do not believe in the "My way is the best and only way" theory, for if there lives any one man who knows it all I have never had the pleasure of meeting him.

There is always a *best* way, and the object of the writer will be to get this best way before his readers, and whether they get this from reading this book or the criticisms and suggestions from some of his readers, is immaterial if the desired object is gained.

The intention of the writer is to tell in the plainest manner possible of the way different classes of work has been done which has produced the best results, as far as his observation has enabled him to judge. And where there exists a probability that, by doing work in a certain manner, poor results would follow, the desire is to explain to them what these results would be, and why they would be produced, that all may avoid doing work

in an improper manner; and should any of my readers "pick me up," and explain better methods of doing running repairs than those which will be described, I shall thank them, and cheerfully "stand corrected." The writer is selfish enough to hope that he will derive as much, if not more, benefit from the corrections and suggestions from his readers than they will receive from reading this book, though no effort will be spared to make it as interesting and instructive as possible.

CHAPTER I.

GRINDING IN BRASS VALVES, COCKS, ETC.

It is a good plan, I think, for roundhouse foremen every morning and noon to personally look over the book in which the engineers report the work to be done on their engines, and to assign to each man under his charge the particular work he is to do. While doing this recently I noticed where an engineer had reported, "Grind in right injector line check," and told a machinist (a new man who had only begun work that morning, and who was awaiting to have his work assigned him) to take off the cap of line check, and examine the condition of the valve, and also to have the boiler washer lower the water in the boiler to enable him to examine the condition of the boiler check valve, and to note the lift of each. Then I wandered around through the house, apparently not seeing anything in particular, but in reality keeping a close watch of Mr. Machinist. The first thing he did after examining the condition of the check valves, as instructed, was to go to his tool cupboard and take out two cans of emery, a little cotton waste, and a squirt can, and start for the engine. On his way there I met him and asked him what he intended to do with those things. Said he, "Grind in the checks; they need it." Right then was when the lecture began, and he was told that the checks did not require to be ground with the emery and oil he

had: he was shown where to get a piece of an old grindstone which had been broken, and was told to powder it up, and sift it through an old red flag which we had for the purpose. Then he was sent to the storeroom for a bar of soap—not cashmere bouquet, but yellow soap. The boys call it "washerwoman's delight," and in an old box lid we mixed the grindstone powder and soap with water into a thick paste.

This for grinding brass surfaces together, when water is used instead of oil, gives the best results of anything we have ever seen used, owing to the fact that the particles of grindstone will not imbed themselves into the brass surfaces, as will the particles of emery, causing the surfaces to cut.

Never grind brass cocks, etc., with emery. The proper way to grind a brass cock (if you have the cock off so you can catch it in the vise) is to catch the large end of the plug in the vise, and grind the shell to it, giving it each time about one-half turn, pulling the shell a little away from the plug after each half-turn, continue this for six or eight seconds; then remove the shell from the plug and clean each thoroughly and rub them together dry: rub hard; do not be afraid they will cut, for they will not, if there has been no substance other than the grindstone powder and soap between them.

When rubbed together dry, the heaviest bearing will be indicated by dark yellow lines. Should these not be universal the entire length of plug and shell, rub clear soap on the dark yellow lines on the plug, and put the paste and water on the other parts and grind again, but only a few turns before cleaning off and examining again. When the bearing is perfect on shell and plug, put a little

beeswax and tallow melted together on the plug, and put it into the shell, and you will have a nice, tight, free-working cock.

Before commencing to grind brass surfaces, pains should be taken to get as nice a bearing as possible by the use of a fine file or scraper, using lampblack and oil, or something of that nature for a marker. Then, while grinding, care should be taken not to bear on too heavily, or grind too long, before separating the surfaces, as this allows the particles of grindstone on each surface to change their positions, and this prevents cutting. Those who will follow these simple directions while grinding brass cocks, etc., will have no cause, I think, to regret having done so. I know of one man at least who believes it to be the correct way, and that is the man who ground the checks; for, said he, "It used to take me longer to get the emery and cuts out than it does now to do the entire job."

While speaking of checks it may not be out of place to suggest here that every time a boiler is washed out the check caps be removed, and pains taken to see that the check valves, and the passages in the check shell are perfectly clean, and that the joints are perfect on the valve and seat; for while boiler is being washed, scale, etc., is liable to be washed over on top of the check valve, and this oftentimes prevents the free working of the injector, and in this case, as in most others, "An ounce of preventive is worth a pound of cure."

CHAPTER II.

RODS.

Too much care cannot be taken to keep rods the proper length. Some of the troubles which arise when main rods are not kept in this condition are, first (and probably the most dangerous difficulty), there is great liability of breaking the front or back head of the cylinders when the rod is too long or too short, as the case may be. Then the brasses are not in their proper position in the strap, and if they are too far out of the proper position the supply of oil from the rod cup is in a measure cut off, and the pin will possibly lack proper lubrication. And again, when main rods are not of the proper length, it is a more difficult matter to set the valves so that the engine will exhaust regularly, or "beat square," as the boys say. This may not be considered by some to be a very serious difficulty, but it sounds bad, to say the least, and I believe that if an engine does not *sound* square it is not using the steam properly, and an indicator card taken from such an engine would, I think, clearly show that something was wrong. These are some of the effects. Now, why are they produced? I think that the reason the first two effects are produced is very plain. If the rod was too long there would not be sufficient room between the front cylinder head and piston head when the engine was on the forward center,

and in case a follower bolt worked loose the cylinder head would be broken sooner, and if the engine was over-pumped and water was worked into the cylinder the cylinder head would be more liable to break. If the rod was too short the back cylinder head would suffer in like manner from these causes when the engine was on back center.

When the brasses are not in their proper position in the strap the oil hole through them is thrown out of line with the hole through the strap into which the oil cup is screwed, and where this difficulty exists to a great extent the oil supply is cut off by the hole through the brasses passing beyond the hole through the strap.

The reason an engine will not sound square when the main rods are not of the proper length is, that if the steam is made to cut off at an equal distance from each striking point (as it should be made to do) there will be more space between the piston and cylinder head in one end of the cylinder than in the other when the exhaust takes place, which causes a difference in the sound of the exhaust.

A full explanation of this will more properly come under the head of "Valve Setting," with which we intend to deal in another chapter.

When a main rod is put up, the engine should always be pinched on the center, and the distance from the nearest striking point to the end of cross head be measured. Then, if the engine has 24-inch stroke, lay an opened 24-inch rule on the bottom guide with one end against the crosshead: then measure the distance from the other end of rule to the other striking point. If these two measurements are the same the rod is the proper length.

In case there is a difference, one-half of this difference is what the rods need to be altered. Some one may say, why write these things, which any apprentice boy should know? I answer, simply because I have seen machinists who considered themselves pretty good workmen put up main rods without taking these measurements, and the piston head struck the cylinder head the first time an attempt was made to move the engine.

If the rod is down at both ends, a good way to get the proper length is to place the crosshead centrally between the striking points, then the distance from the center of the crosshead pin to the center of the forward main shaft is the length the rod should be from center to center of brasses.

When rod brasses are reduced much care should always be taken to reduce each half square with its edges and sides, as this causes the parting edge of each brass to come squarely together when they are keyed in the strap. The brasses in the forward end of a main rod should be reduced enough, I think, to allow the parting edge of each half to stand a full thirty-second of an inch apart when they are keyed sufficiently tight to the pin, as this will allow the engineer to key them up two or three times before it again becomes necessary to reduce them, and as these brasses never revolve entirely around the pin, there is less liability of their "hugging" the pin and heating.

I would not advise a person to leave the brasses in the back end of a main rod open, as at each revolution of the driving wheel the pin makes a complete revolution in these brasses, thus increasing the liability of heating if they are keyed too tightly to the pin. They should be

reduced so that when the key is driven down solid the brasses will revolve freely on the pin, at the same time having no "pound" or lost motion between them and the pin. This can better be determined by placing them in the strap and keying them to the pin; for when the brasses are put together out of the strap, and only the calipers relied on for the fit, it is only guess work, as one has to *allow* so much for keying them together; but when a person keys them together on the pin he can revolve them before the end of the rod is put into the strap, and he does not need to allow anything, for then he *knows* how they fit.

When making the fit to the pin I would not advise draw-filing the brasses, as this brings the file marks parallel with whatever lines or marks are in the pin, if it is cut in the least, and this makes them more liable to heat and cut. I think the best way is to cross-file, using a rather fine file for the finish. I do not think it necessary to use a scraper, for the scraper has had its day for such work. It is better, I think, to give all parts of an engine what space they require with a file than to be compelled to run it around the shops and yard for a week or two that it may free itself before we dare put it into freight service, as was the custom fifteen or twenty years ago.

For brasses in the back end of main rods, I think that those which have babbitt metal inlaid in the bearing surfaces give the best results, as babbitt, being an antifriction metal, wears the pin smooth.

If any foreign substance gets between the brasses and pin it cuts out the babbitt metal. This causes the brasses and pin to heat, and often melts the babbitt. In case a

person has a pair of brasses out of which the babbit has been melted as described, and the time to make the repair is limited, after the brasses have been nicely fitted to the pin, a good substitute for the babbitt is a piece of sole leather fitted into the slot in brass from which the babbitt was thrown.

In case the pin is very rough this will be found better than the babbitt, for if any piece of scale from the pin, or piece of foreign matter of any kind (which is hard), gets between the pin and brass, it will imbed itself in the leather instead of cutting out a piece, as it would from babbitt. These foreign particles will remain in the leather below the surface and have more of a tendency to wear the pin smooth than otherwise.

A little plumbago and sulphur mixed with tallow put on such a pin before the rod is put up will be found very beneficial.

There are some engineers who imagine that every time they set up a wedge the length of the side rods should be altered. This, I think, is a sad mistake. It causes the engineer sadness on account of the way his engine will ride, and the roundhouse foreman, who is expected to keep the engine in good repair, does not feel very jubilant over having to take down the rods and re-adjust them every trip or two. I believe that a pair of side rods put up in the proper manner should run twelve or fifteen months without being adjusted or having the brasses reduced, provided, of course, that all other parts of the engine are kept in good repair.

SETTING UP WEDGES.

The first thing to do when side rods are to be put up is to see that the wedges are set up properly. This can be

done very satisfactorily in the following manner: First have the engine on a piece of straight level track, then get under and pull down each wedge until it is quite loose; now have the driver pinched as far ahead as possible and held in that position with the bar. Set the wedge up quite snug and try if the driving-box will stick between the wedge and shoe by having another man put a pinch bar ahead of the wheel and both men jump the wheel together. Set the wedge up until the box *does* stick, then draw the wedge down until the box just works freely between wedge and shoe. Treat each wedge in a like manner and the wedges will be in a proper position. Now pinch the engine a full revolution on each side and try the trams on the main centers and pins at different points to see if the main centers and pin centers tram correctly. If they do, see that each brass is fitted so it can be keyed solid in the strap and still be perfectly free on the pin; then put the engine on the center on the side you wish to put the rod up, and put the forward end of the rod up first. Now, if the engine is perfectly cold put the rod up as tight as possible between the pins. I have never known of a case where a side rod was put up too tight between the pins when the engine was perfectly cold. On the other hand, I have seen too many rods put up too loosely between the pins, and when this is the case, the strain (when the engine is warm) will come on the rod bolts and they will be sheared. A side rod can be sprung between the pins if too long, but it cannot be stretched a particle if too short, and, consequently, the rod bolts suffer, though this assertion is not intended to convey the idea that a side rod will run good if too long; for if too long the strain is on the pins, though there is

less trouble from a side rod which is a little too long than from one left a little too short.

TRAMMING.

In case the pins do not tram correctly with the main centers, care should be taken to note the greatest difference shown between the pins, then put up the rods as described, being careful to file out of the back half of the back connection the full amount of this difference. This will insure the rod passing over the longest point between the pins without binding. Rods put up in this manner will run nicely when the pins are considerably out of tram, and if the engineer who runs the engine can by any hook or crook be made to believe that he *must* let them alone, I feel confident that no trouble will arise for a long time. But it is a difficult matter to make some engineers believe that their side rods should not be tampered with, and this fact is what makes me pin my faith to solid ended side rods, that is, those whose brasses are pressed into the rod in the form of a bushing, and that have no straps, bolts or keys; for an engineer cannot change the length of these, and in our experience they have always given very good service.

CHAPTER III.

SPRINGS.

If a driving spring or engine truck spring is allowed to remain in an engine after the set is nearly gone, it is liable to cause serious damage to the wheel flange.

The theory has often been advanced that if one side of an engine is allowed to remain lower then the other side, the engine will crowd to the higher side, and for proof a belt running over a crowning pulley has been cited. This is an erroneous idea. It is true that a belt will run to the highest point of a pulley face, and this is the reason why some pulleys are made crowning, or left larger in diameter in the center of the face than at the edges, as this will insure the belt running in the center of the face. The principle involved in this case is altogether different from that in an engine with one side lower than the other. The belt principle I think can readily be understood by reference to Fig. 1, page 12, which represents a belt passing over two pulleys, the face of one having been turned straight, and that of the other crowning; the representation is exaggerated, to better illustrate the principle. Now, the belt when placed at the edge of the crowning pulley will take the position shown by the heavy lines, and will not be in a straight line from one pulley to the other. The edge *A C* will be drawn tighter than the edge *B D;* the bearing *C D* is uniform, but the bearing at *A* is harder than at *B*. When the pulleys are turned on their axis it has a tendency to straighten the belt, and to make

the bearing from *A* to *B* uniform; the consequence is that the belt is moved on the crowning pulley to the position indicated by the dotted lines.

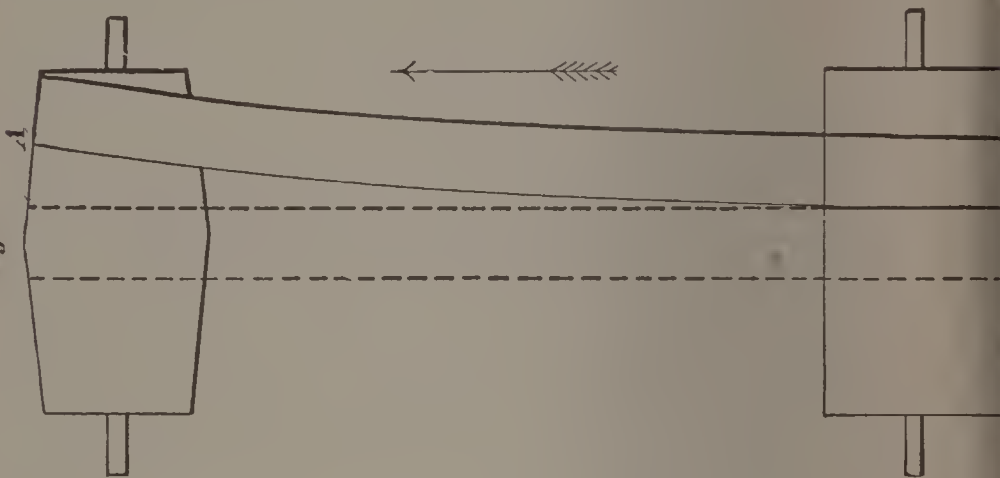
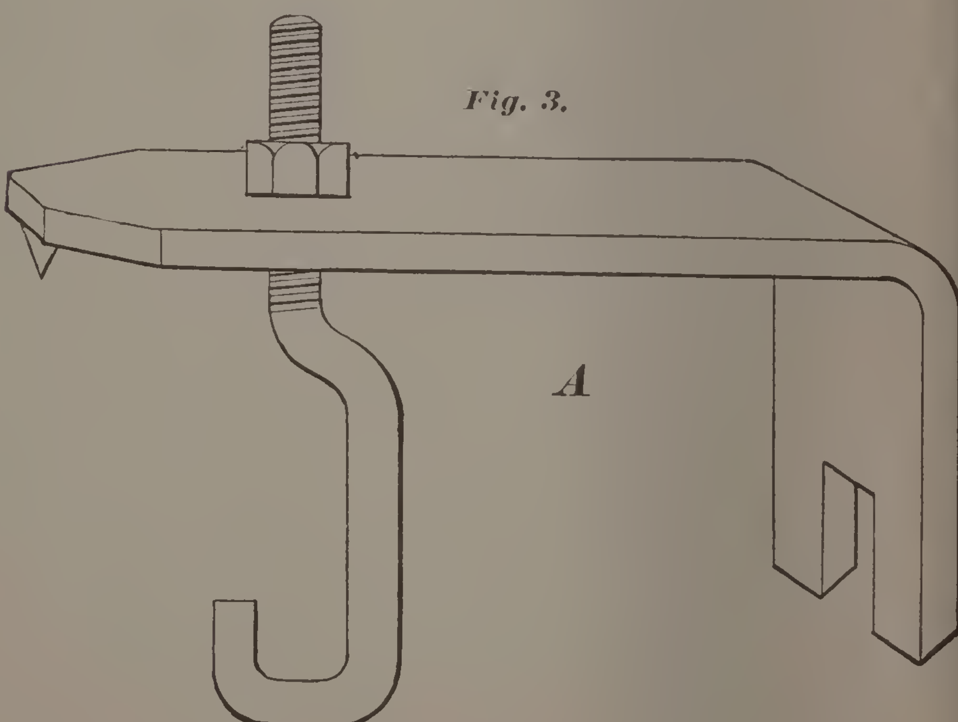


Fig. 1.

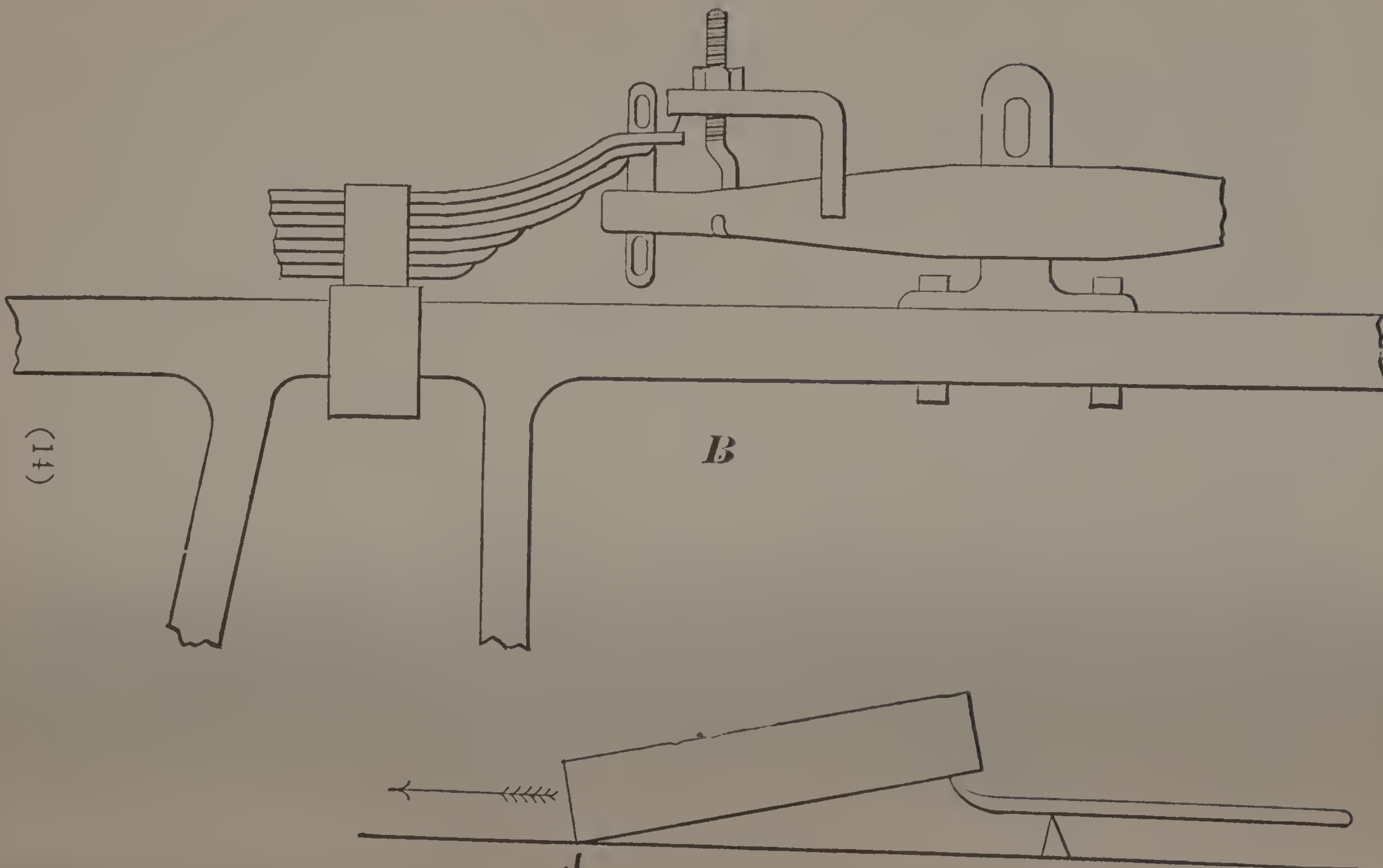
Fig. 3.



The cause of an engine sometimes having one side lower than the other is that the weaker spring allows the engine to settle, and the spring on the opposite having more "life," raises the engine, consequently more weight is thrown on the weaker spring, and the engine has a tendency to move in that direction, which crowds the wheel flange against the rail. This principle is demonstrated by cut, page 14, which represents a weight, one side of which is raised by means of a lever; this throws a large proportion of the weight on the point *A*, and the weight has a tendency to move in the direction indicated by the arrow; in this case the lever represents the action of the "live" spring, and I think proves that an engine will crowd the wheel flange to the side which carries the weak spring. When a wheel flange begins to cut, it should have immediate attention, for when it is allowed to run in this manner until it is quite sharp, much more has to be turned from the face of the tire to entirely remove the groove worn by the rail at the base of the flange.

The most serious difficulty attending sharp wheel flanges is the liability of derailment, caused by the sharp flange "climbing" the rail at low joints and at curves.

When springs show weakness by allowing the engine to settle, the best way to proceed is to remove the weak spring, and substitute either a new one or one which has been re-set; for when a spring begins to lose its set, clipping it up gives but temporary relief from the trouble, as it will generally straighten out again after the engine has made a trip or two. But it is not always possible to replace an old spring with a new one, as a sufficient number of new springs are not always kept in stock, and where it is necessary to clip driving springs, the old-time


B
A

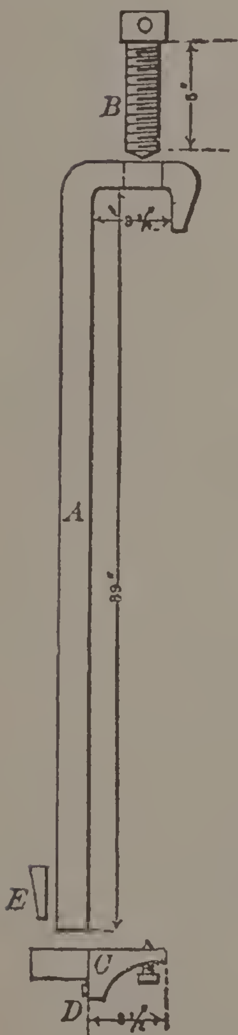
U piece of iron may be placed between the upper surface of the spring and the hanger gib, and where this is to be done at the back end of the forward driving springs, or at the forward end of the back springs, it can quickly and easily be done by the use of the little arrangement shown in Fig. 3, page 12.

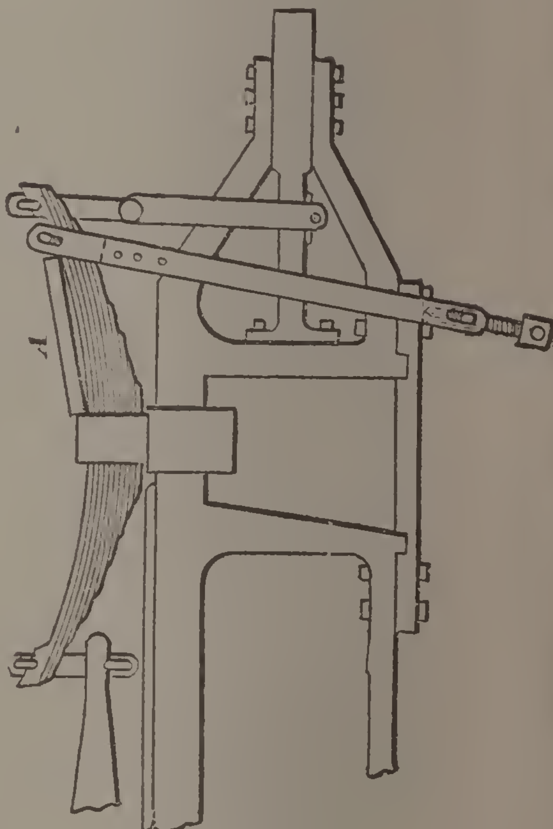
Take a piece of $1\frac{1}{2}''$x$3''$ iron and cut a slot in the end wide enough to take the top edge of the equalizer; bend it as shown at *A*, then as close to the straight end as possible drill a $\frac{5}{16}''$ hole about $\frac{3}{4}''$ deep; into this insert a tempered steel pin having a sharp point; the end which contains this pin should be $\frac{5}{8}''$ wide by $1\frac{1}{2}''$ high. Then make a hook as shown at *A*, of $1\frac{1}{4}''$ round iron, with straight part threaded; hook this under the equalizer, then slip the bent piece of flat iron over the top end and adjust it to the equalizer and spring as shown at *B*. By screwing down the nut the end of the spring will be lowered when the U piece can be inserted from the opposite side of the hanger from which the pin rests.

When it is desirable to remove the gib from the equalizer post we use a tool of which the following is a description, and obtain good results:

The best tool we have been able to find for the purpose mentioned, is to take a piece of $1\frac{1}{2}''$ square steel and have it bent as in cut *A*, page 16. This piece has a boss on top, through which passes a $1\frac{3}{4}''$x$5\frac{1}{2}''$ steel screw *B*; the foot *C* can be made of either steel or iron, a small, sharp-pointed set-screw passing through it, as shown. This foot has small projection on bottom, as shown at *D*, which holds pin used in adjusting to engines of different built frames. This jack is placed in position by placing the long steel piece perpendicularly beside air cylinder,

close to engine frame, allowing the hook at top to drop over between equalizer and fire-box: this allows the tempered point of large screw to rest on top edge of equalizer.



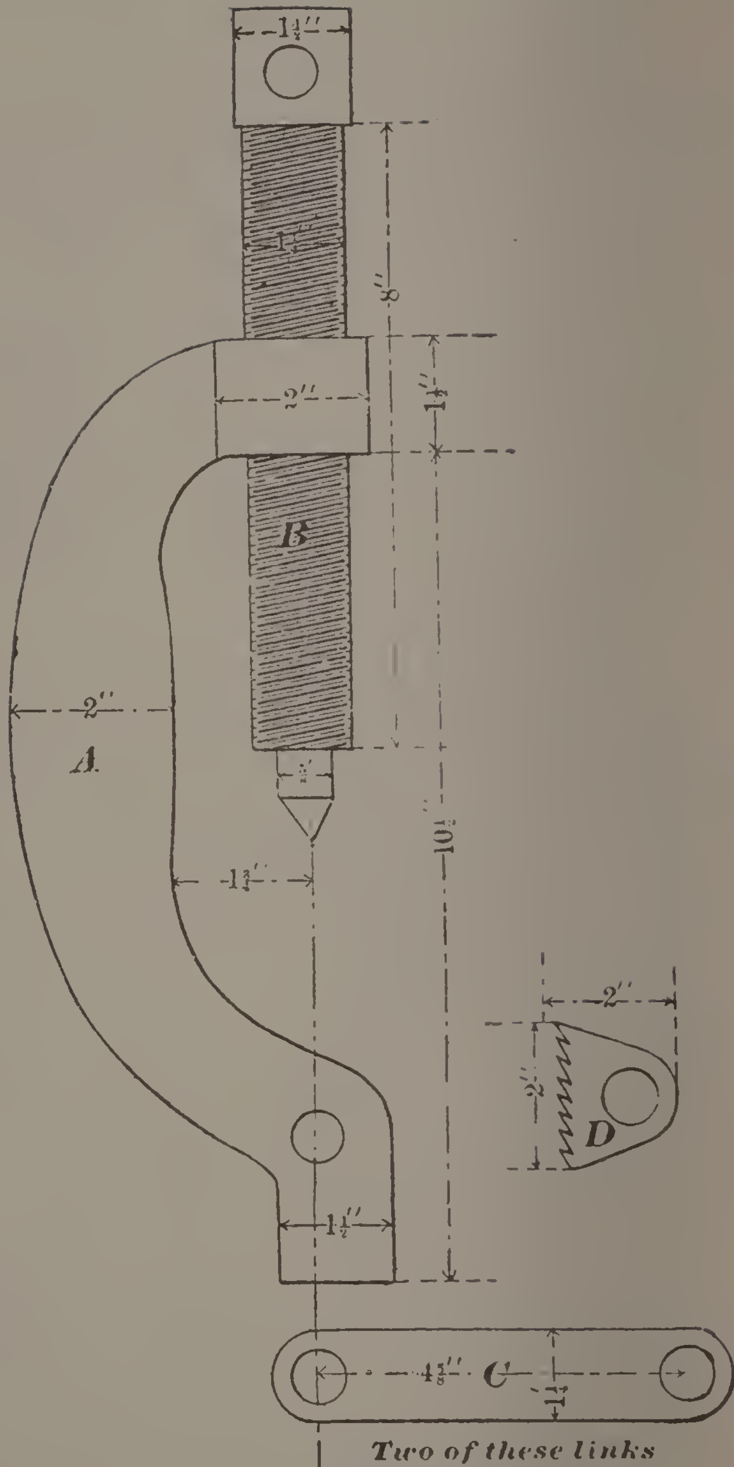


The foot is then slipped up an upright piece until point of small set-screw strikes bottom of lower rail of engine frame, and fastened in this position by driving home the wedge. As pressure is applied to point of large screw, the point of small set-screw is pressed into frame, which prevents it from slipping. The hook at top prevents the arrangement from slipping there, and the equalizer can easily be screwed down as far as desired.

This contrivance can be easily and quickly set, and is absolutely safe. We believe that safety and dispatch in doing the work should be considered while making tools, rather than original cost, for a good tool soon pays for itself.

When weak engine truck springs allow the engine to settle too much in front, a flat iron ring made in halves is often put in the female center casting to raise the engine; this is not a good practice, as by this means the engine is only raised away from the truck, and the truck frame is as near the top of the truck boxes as it was before. In case it is really necessary to clip an engine truck spring, it should be done by placing the clip between the upper surface of the spring pocket and the lower surface of the truck frame; for in this way the distance between the truck frame and engine remains the same, and the truck frame is raised away from the top of the truck boxes.

When one side of the pilot of an eight-wheeled engine is very high from the rail, and the opposite side is very low, those in charge often order the truck spring on the lower side out, and a new one substituted. Now this may often be the case when neither spring is weak, the fault being the weakness of the back driving spring on the low side, and by replacing this with a good spring the engine



Two of these links

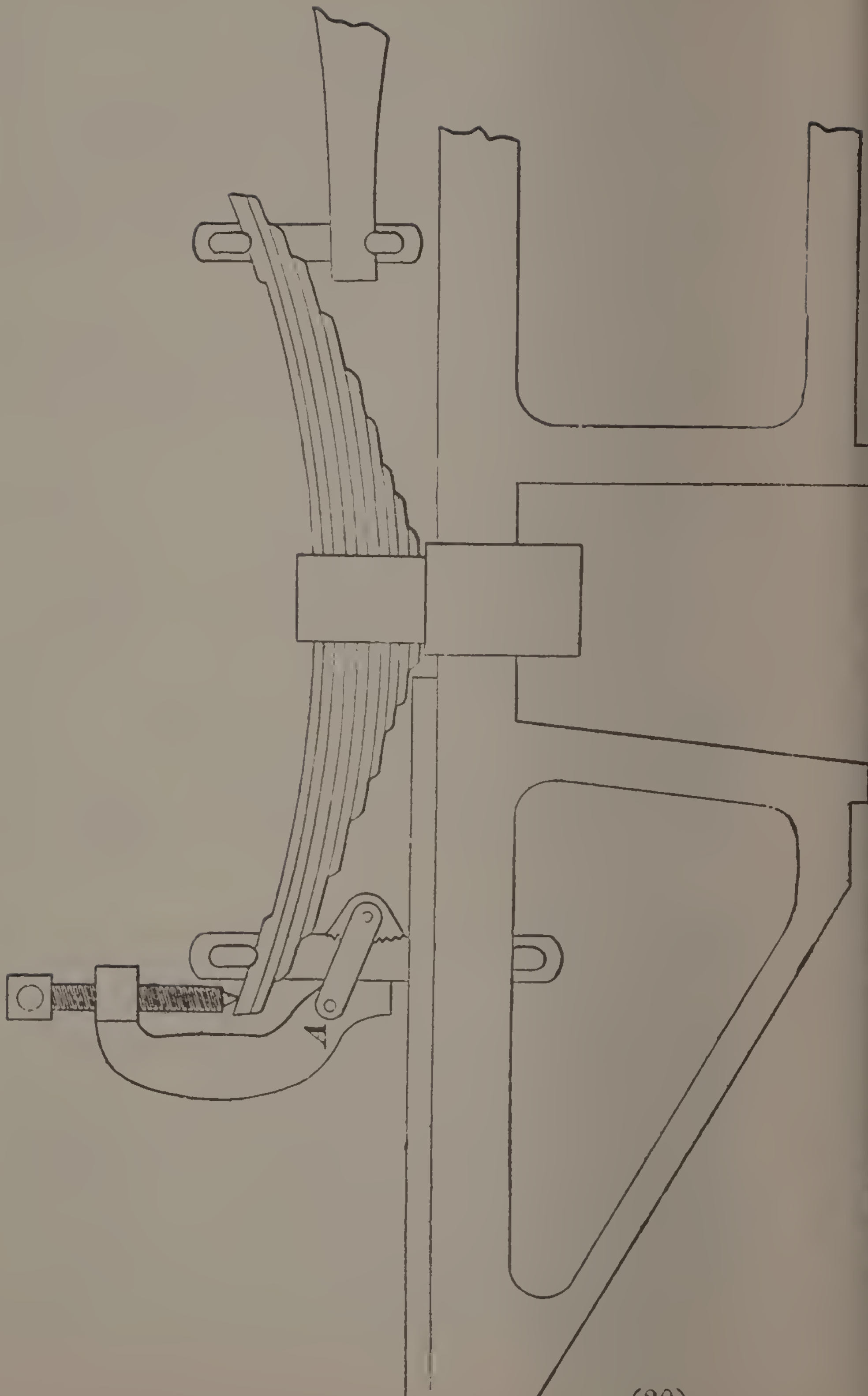
is raised at that point, and lowered at the opposite forward point, and the engine is thus brought level.

For the removal and renewal of back driving springs, the use of the following described little tool will be found very satisfactory:

The enclosed rough sketch will enable you to form some idea of it, I think. *A*, cut, page 18, represents the body of jack, made of 1″x 1½″ iron; the top end, through which the screw passes, we made 1½″ thick, with 2″ face.

The screw *B* we made of steel 1¼″ x 8″. These, with two steel straps *C C*, and a steel block *D*, constitute the jack. The steel block *D* we fluted on the edge, which enables it to take a firm hold of the spring hanger. The fluted face of this block is 1″x 2″. The two straps *C C* we made of spring steel ⅜″x 1¼″, and pinned one each side of body *A* and block *D*, with ¾″x 2⅛″ steel pins, allowing body and block to move freely between them. We put ⅛″ spring cotters through the ends of these pins, as they can be more easily removed than nuts.

To remove a spring with this jack, first raise the back end of equalizer as high as possible, and block it there. Then remove pin *A*, cut, page 20, leaving the other pin in place, pass a strap each side of spring hanger, *from the front*, and connect straps again to body *A*. When the hardened point of screw is applied to driving spring, the body *A* and block *D* are firmly clamped to spring hanger, holding it rigidly in place; at the same time the driving spring is compressed, rendering the removal of gib easy. As the screw is slacked off, after the removal of gib, the jack will roll on hanger at the point where straps *C C* are


A

connected to body *A*, and thus conform to upward and forward motion of the back end of driving spring, as the pressure is removed, thereby preventing the point of screw from slipping off the spring.

The front driving springs may be quickly and safely removed and applied by the use of the following described tool:

It will readily be seen that the jack used for removing back springs cannot be used for the removal of front springs, owing to the lack of space between the top of front spring and boiler.

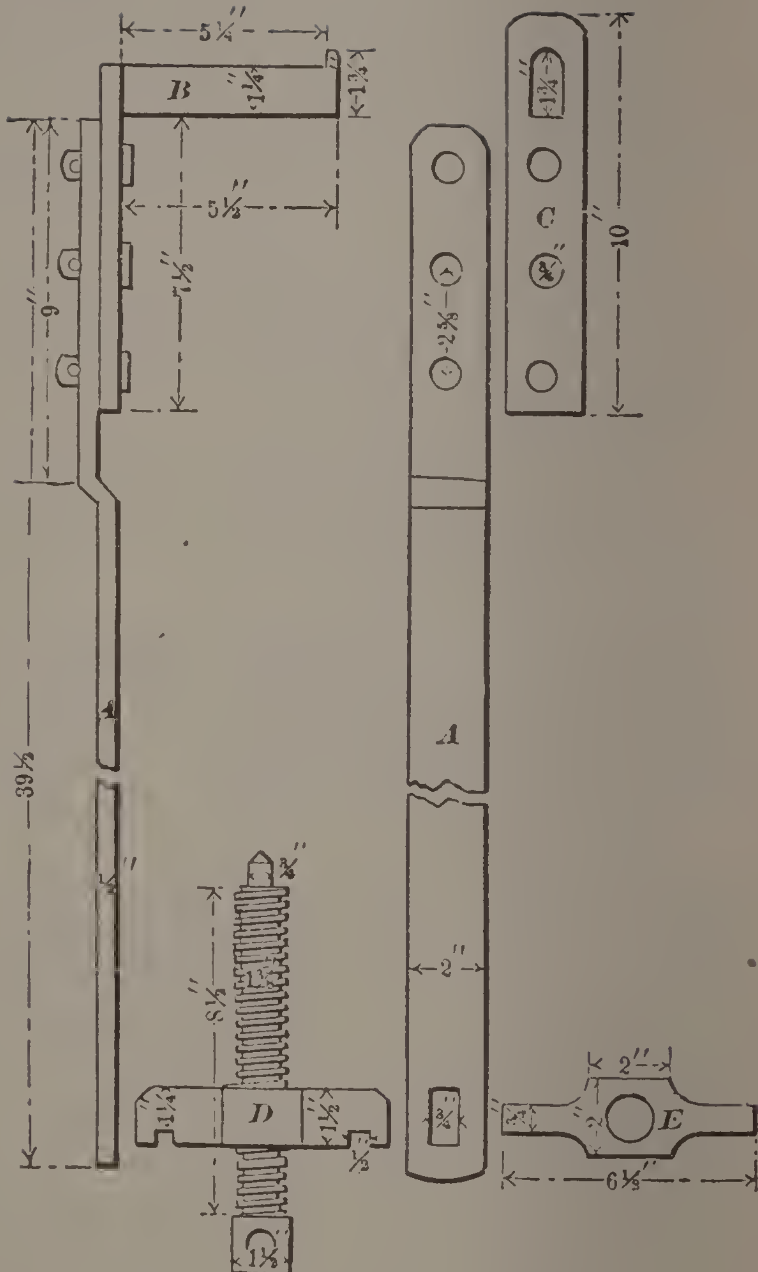
I have removed front springs by the use of a chain and bar. Have also used a jack with chain attached to it, but I have known several cases where men have been injured by the chains breaking.

To avoid this danger, in place of chains I use iron strips $\frac{1}{2}''$x $2''$ (*A*, cut, page 22). These strips are each in two parts, the longer piece being offset to receive the shorter one, which, when they are pinned together, leave the inside faces parallel when placed in position for removing spring.

By drilling three holes in each piece these strips can be lengthened or shortened, as the different builds of engines may require.

The long and short parts of each strip are pinned together with $\frac{3}{4}''$x $1\frac{1}{2}''$ steel pins, through the ends of which $\frac{1}{4}''$ spring cotters pass. The lug *B* is jumped onto the face of the short piece, as shown by cut. Both the upper and lower edges of this lug should be rounded, as should be also the upper part of the slot through short piece *C*.

The crosshead *D*, through which the screw passes, has


B
A
C
A
D
E

a 2″ face, as shown at *E*. The wings of this head have $\frac{3}{8}$″x $\frac{1}{2}$″ slots cut in them, as shown, to receive the long strips.

The screw has square thread, is $1\frac{3}{8}$″x $8\frac{1}{2}$″ with a tempered steel point.

A forward driving spring is removed with this device as follows:

First jack the engine up until most of the weight is removed from the springs, then pass the strip to which the lug is attached up on the *inside* of engine frame, and hook the lug over the top of spring, as far forward as possible.

Now pass the other strip up on the *outside* of engine frame, between driving wheel and frame, and hook it over end of lug. To prevent the apparatus from slipping down the spring towards the band, place a stick of the required length between the band and lug, as shown at *A* (Fig. 2, page 16). After having placed this stick in position hook the wings of crosshead through the square slots in lower ends of strips, and pass the screw and crosshead back under the pedestal brace, as shown in Fig. 2, page 16, andapply the point of screw to brace.

This appliance is cheaply made, and there is no danger of it slipping or breaking, and injuring a person.

It is quite a common thing to see the forward ends of driving spring equalizers much lower than the back ends. When this occurs, the forward driving springs should be examined; also the distance that the pilot stands from the rail should be noted; for if the forward driving springs are weak, the back springs pull the back ends of the equalizers up, and from the fact of the fulcrum being in the center, the forward ends are lowered. Now, if the front end of the engine is too high, too much weight is thrown

on the back driving springs, and the results described are again produced. When this occurs, substituting good forward driving springs for the weak ones, or removing clips from above the engine truck spring pockets, will bring the engine and equalizers level.

CHAPTER IV.

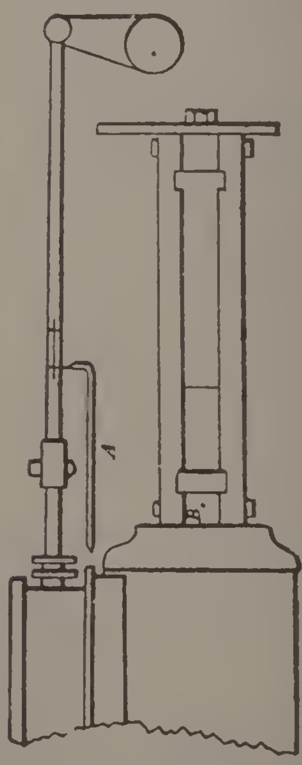
SETTING SLIDE VALVES.

Nearly every work on locomotive maintenance has a rule for setting valves, but not one mechanic in ten would follow to the letter any rule I have ever seen given while doing this work, and should a novice undertake to do this work with nothing but the rule as given to guide him, I am confident that he would not meet with success.

The work of Angus Sinclair is as clear as any on this subject, and, as he says, "A person can better learn this work by taking part in it." Now, in writing upon this subject I do not wish to be understood as criticising such writers as Sinclair and Forney. Nor do I intend to teach any experienced machinists in this work; but what I wish to do is to tell the younger mechanics some of my own experience in this line, and to tell them in such a manner that, by taking this book and following the directions given, they will meet with fair success in setting locomotive valves.

We will assume that we have in the roundhouse a standard eight-wheeled engine, with cylinders 17″x24″, and that the valves of this engine have been reported as being "out bad," and we are to set them. Now, if there are no rollers upon which to turn the forward drivers, and the engine has to be pitched forward and backward, you should have two helpers to do this work. The first thing

D
E
F



A

to be done is to "gauge off" the engine—that is, to mark on the valve stems the points at which the valves close the steam ports. While you are taking off the nuts which hold down the steam chest covers, have the helpers disconnect the tender, and if the weather is cold they should run all the water from it into the pit, then push it outside.

It is not necessary to lift the chest covers to the floor, but just raise each and let them rest on top of the studs; then by standing on the cylinder, with the feet close to the steam chest, a man can raise the outer edge of the cover and push the inner edge under the heads of the bolts which fasten the cylinder saddle to the smoke arch, and the cover will remain in this tilted position.

Now get two pieces of thin roofing tin, about 1″ wide by 10″ long, rivet these together at one end, using one rivet. They can then be opened and closed similar to a pair of shears. Then go to the side of the engine where the pins are nearest on the quarter (either up or down), and have the reverse lever moved until one port is opened; then put the loose ends of your tin shears into the open port and open the tins until they will span from end to end of the port. Now have the lever moved *slowly*, and stop when the edge of the valve will have pinched the tin so it can just be moved up and down; then put a prick punch mark on that part of the cylinder upon which the steam chest rests, and with a stiff steel tram, bent as shown at *A*, cut, page 26, and with the point on straight end in the punch mark on the cylinder, make a good deep mark on the valve stem with the point on bent end. When the valve stems are not coupled with a "stretcher" (or right and left nut), this tram is best

about 24″ long. But when the stretcher is used the tram must be short enough to allow the stem to be scribed forward of the stretcher. Now remove the tin and have the lever moved until the other steam port is opened; then place the tin and repeat the operation just described.

Now have the reverse lever put in the center or out-notch in the quadrant, and disconnect the forward end of the back-motion eccentric rod on the opposite side of the engine. A helper can then take hold of the bottom of the link and move the valve stem forward and back for you while you gauge off this valve. Now see that the wedges are set up sufficiently tight to allow the driving boxes to move up and down freely. Then replace the steam chest covers and connect the eccentric rod.

The back ends of the main rods should now be disconnected, and the crossheads be moved forward until the pistons strike the forward cylinder heads. Then mark the edge of the guides at the point where the forward ends of the crossheads rest. Then move the crossheads back until the pistons strike the back cylinder heads, and mark the guides at the point where the back end of the crosshead rests. These marks are called the striking points. Now connect the main rods.

With a key seat rule now scribe a horizontal line along the valve stem, crossing the heavy lines made with the valve tram and prick punch lightly where these lines cross. Then with a small pair of sharp-pointed dividers get the exact center between these punch marks, and punch this center on the horizontal line. Now move the reverse lever until the valve tram will reach from the punch mark on the cylinder to this central punch mark, and see

if the outside rocker-arm is at right angles to the guides. This can generally be done by measuring from the back of the guide yoke first to the center of the rocker-shaft, then to the center of the pin in back end of the valve stem. If these measurements are equal the stem is the proper length. If they are not, the stem must be lengthened or shortened the amount that the center of the valve stem pin is forward or back of the center of the rocker-shaft.

Look the engine over carefully now, and be sure that all bolts and nuts are securely in place, and you are then ready for action with the pinch bars.

Now, as the engine is standing under the smoke-jack, it is handier, I think, to back the engine while taking the dead centers, and to facilitate matters, it is best to begin with the left pins on the lower forward eighth, for reasons which will be explained farther on.

Now put the reverse lever in the full back motion, and pinch the engine backward until the front end of the crosshead is flush with the back edge of the oil slot in front end of guides. Then prick punch the forward guide block as at *B*, and insert one point of a small steel tram, bent as shown at *C* (the points of this tram should be about 6″ apart); with the other point scribe a good plain line on the side of the crosshead. Then take a stiff steel tram, bent the same as the crosshead tram, with the points about 24″ apart, and hold it in as near a level position as possible against the driver and wheel cover, prick punch the cover at *D*, insert one point, and with the other scribe a line across the tire as at *E*.

Now hold one point of the crosshead tram in punch mark on guide block and pinch the engine back carefully.

The mark scribed on the crosshead will then move forward of the other tram point, and for a moment stand stationary at the dead center. It will then start backward. Stop pinching the engine when this line on its backward journey exactly reaches the tram point. Then take your wheel tram and scribe the second line on the driving tire shown at *F*. Now with a pair of maphrodite calipers scribe a line intersecting those made with the wheel tram, about half an inch above the lower edge of the tire, and carefully prick punch the exact point where the lines cross, on the line which you last made get the exact center between the two punch marks, and with a piece of chalk draw a small circle around it. This is called the dead center mark, for when the engine is moved either backward or forward until the wheel tram will reach from the punch marks on the wheel cover to one of the marks obtained in the manner described the engine will be on the dead center. This operation must be performed four times to get the forward and back centers on each side of the engine. We now have the left forward center mark, the next one to get is the right forward. This is done by working exactly as you just did to obtain the left forward one. Next comes the left back center; you get this in the same manner as you did the forward ones, except that you must prick punch the guide block in the back ends of the guides, and work with the crosshead at that point instead of at the forward ends. Now for the last center, which is the right back one. After having obtained this in like manner the engine will stand with the pins on the right side, a little below the back center. Now pinch the engine back until these pins are nearly on the lower quarter, then put the reverse

lever in full forward gear and pinch the engine forward, holding one point of your wheel tram in the punch mark on the wheel cover. Stop pinching, and remove the pinch bars, when the other point will go *fairly* into the center mark on the tire which has the circle around it.

Now take the tram with the straight end with which you marked the valve stem, and with the point on the straight end in the punch mark on the cylinder, scribe a light line on the valve stem. Now pinch the engine forward again and go to the left side, catch the back center and mark the stem; then go to the right side again and get the forward center, and with the valve tram make the second light mark on the valve stem. Now with the small dividers see if the two last lines scribed on the stem are an equal distance from the center point between the two punch marks; if they are, the eccentric rod is the proper length. If they are not equally distant from the center mark, put one point of the dividers on the center mark and bring the other divider point to the light line, which is the *nearer* to the center point; then turn the divider point toward the light line, which is the farther from the center point, and note the difference. *One-half* of this difference is what the length of the eccentric rod must be changed; if the line nearest the center point is *forward* of it the rod must be *lengthened* one-half of the difference shown; if it is *back* of it the rod must be *shortened* one-half of the difference. Now I consider it good policy to adjust each eccentric rod to the proper length as you go along, for this reason: We are now working on the right side of the engine, and the pins are on the forward dead center; in this position the eccentric rods are not crossed, as they would be if the engine was on the back

center, and we can easily get the bolts out of the back ends of the rods and slot the holes in the straps if they require it; this we could not do if the engine was on the back center, for the rods would then be crossed, and if you wait before making the changes until you find what each rod requires, you will have to do much more pinching to get the engine into the proper positions to allow the bolts to be removed should the holes require slotting, and this is the reason why it is best, when you start to take the dead center points, to begin with the left pins on the forward center and pinch the engine backward and get the left forward center first; for then when you are ready to change the forward rods the pins will always be on the forward centers, and if you find that the holes in the straps require slotting you can remove the bolts and slot the holes, and then you can always remove the bolts from the back rods and slot the holes in the straps. After you have adjusted a rod, always pinch the engine nearly a quarter of a turn in the opposite direction from which you caught the dead center point, for by so doing all lost motion in the working parts of the engine will be taken up when you pinch the engine to its original position again; catch the center and see if the adjustment is correct. When the adjustment is correct note the lead shown. The lead is the distance that each light tram mark on the stem is outside of the port closing lines when the eccentric rod is the proper length. Should the light tram marks come inside of the port closing lines after the rod has been adjusted to the proper length, it is called blind, the distance from tram mark to port closing line.

Now to return to our work. When we have the right

forward rod properly adjusted, we pinch the engine forward again and go to the left side. Catch the forward center and scribe the second light line on this valve stem. Adjust this forward rod as just described, and note the lead.

Now pinch the engine forward nearly a quarter of a revolution, put the reverse lever in full back motion, and, pinching the engine *backward*, find the proper length of each back rod, and note the lead on each side as soon as each rod has been properly adjusted. The requisite amount of lead can now be given the engine by moving the eccentrics on the shaft. Never move an eccentric on the shaft until the rod is the proper length. If the work has been carefully performed as described, the engine will be square in full forward and back motion. The engine now stands with the right pins on the back center. Put the reverse lever in the second notch in the quadrant forward of the center, or "out" notch, and pinch the engine forward, holding the valve tram in the punch mark on the right cylinder. Stop pinching when the point on bent end of tram will go fairly into the port closing line on the valve stem, and with a pair of dividers measure the distance from the striking point on back end of guides to the back end of crosshead, and write this measurement down. Then go to the left side, pinch engine forward until tram point will go fairly into the back port closing line on stem, and measure the distance from the back striking point on guides to the back end of crosshead.

Care must be taken to mark down each measurement. Now go to the right side again and pinch the engine forward until tram point will go into the forward port clos-

ing line, and measure the distance the crosshead will have traveled backward from the forward striking point. Now if this distance is not exactly equal to the distance the crosshead traveled from the back striking point when steam was cut off, then the cylinder is receiving more steam in one end than the other. For instance, if from back point be 6″, and from the forward point be 8″, the cylinder is receiving 2″ more steam in the front end than in the back end; to make it work evenly the distance must be 7″ from each point. To do this, pinch the engine backward until the crosshead is near the forward end of stroke. Set your dividers to 7″, and with one point in punch mark on forward end of guide, pinch the engine forward until the forward end of crosshead has traveled backward the distance your dividers will span. Now with the valve tram make a light mark on the valve stem. The line in the present instance will come just forward of the front port closing line, and the distance between the two lines will be what the forward eccentric rod needs shortening to make the steam cut off from each end of the cylinder at 7″ travel of crosshead, provided the rocker-arms are of equal length. Should the upper arm be longer than the lower arm, as is often the case, the amount to change the rod will be a little less than the distance between the two lines on the valve stem. When the *forward* end of the cylinder receives the greater amount of steam the eccentric rod must be *shortened*. When more steam is admitted to the *back* end of cylinder the rod must be *lengthened*. And when the difference is not too great the rods can thus be changed to bring the engine square, when "hooked up," without materially affecting it while working full stroke. As-

suming that we have adjusted the right forward rod to make the crosshead travel equal, we will now go to the left side of the engine, and, pinching the engine forward, ascertain the distance this crosshead will travel from the forward striking point when steam is cut off. If the distances from front and back points are unequal, adjust the rod as just described. Having done this, see if the distances the crosshead travels from the left striking points are equal to those on the right side of the engine. If they are not, one side of the engine is working more steam than the other. This may be remedied by raising the tumbling shaft arm, or shortening the link hanger on the side working the greater amount of steam. Or what is easier, and most frequently done, is to put shims between the tumbling shaft box and frame on the side using the most steam.

The amount of shim to be used can only be determined on trial, though usually every $\frac{1}{32}''$ of shim will reduce the cross-head travel about $\frac{1}{4}''$. It is seldom necessary to run an engine over "hooked up" in the back motion. Be sure that the back eccentric rods are the proper length when the engine is working full stroke, and also that the eccentrics are so placed on the shaft that the valves have an equal amount of lead. Then follow closely the directions just given for running the engine over with the reverse lever in the second notch forward of out notch, and I think that you will not be troubled with the engine not sounding square.

CHAPTER V.

FLANGE WEAR.

Probably one of the most difficult matters with which roundhouse foremen have to contend in the line of running repairs is the wear of driver and truck wheel flanges. It is difficult in this way: where a wheel has been allowed to run to one rail more than to the other until the flange has become sharp, and a groove worn in the face of the tire, it is oftentimes a very difficult matter to get the tire to bear on the rail out of this groove.

The flange of a driving tire wears sharp owing generally to one of two causes. Either the engine is low on its springs at that point, or the drivers are not square with the engine frames, or, as it is generally expressed, they are out of tram with the engine frames. In cases where only one driving tire is wearing the flange sharp (as often occurs) there is very little doubt that the engine is low on that spring, and is crowding that flange to the rail, though if the wear is noticed on either of the front drivers it may be caused by a weak engine truck spring on the side where the flange is cutting. As soon as the marks on a tire indicate that the flange is running close to the rail it should have *immediate* attention, for this is one of the jobs which it does not pay to put off until a more convenient time, for if action is taken as soon as the difficulty is discovered the proper remedy may be applied, viz.: either raising the engine at the proper points or throwing the wheels in the proper direction, and the

trouble be easily overcome. But where a person is careless, and neglects to apply the remedy as soon as the need of it is discovered, it takes but a very short time for the rail to wear a groove in the tread of the tire and wear the flange sharp, and where this exists to any extent the safety of the traveling public demands that the drivers be removed and the tires be turned. And in a majority of the shops this means taking the engine out of service for a week or ten days, at the least calculation, whereas had it been taken in time, the whole difficulty might have been remedied in twenty minutes or one-half hour.

In cases of driving flange wear, the old adage, "A stitch in time saves nine," is certainly true. Cases are quite numerous where one of the back driving flanges will begin to cut. Where this occurs, the height of the engine at this point, in comparison with the height the engine stands from the other driving-boxes, should be noted. It will generally be found that the engine is low at the driver which carries the cut flange, and removing or clipping up the driving spring will remedy the evil; but after the flange is made to run free from the rail it should be carefully watched for some time, to see that the engine does not settle at this point, for it will wear itself away faster than would be imagined if allowed to come in contact with the rail the second time.

Suppose that both drivers on one side of an eight-wheeled engine are cutting, and the distance between the bottom part of the spring saddles and top part of the engine frames are about equal on each side, it would be safe to conclude that the main axles are not square with the frames. The first thing to ascertain in a case of this

kind is whether the center casting, which rests in the engine truck center casting, is in an exact central position between the engine frames. In case it is not centrally located it should be changed to that position, for when it is out of center it often causes both the driving flanges and engine truck flanges to wear sharp. And right here let me say that I am not an advocate of what is commonly called a swing beam engine truck, that is, one having a movable center casting; for my observation leads me to believe that engines having the swing beam trucks wear the flanges of both the engine truck wheels and forward drivers more than do engines having the rigid trucks, when the engine is kept away from the side bearings of same.

Now to return to the case in hand: Should the center casting be centrally located the trouble is surely not there, and to ascertain if it is caused by the driving axles being out of square with the engine frames, first set up the wedges until the driving-boxes will just move between the shoe and wedge, then clamp a straight-edge about just eight feet long flatwise on top of the engine frames, forward of the tumbling shaft boxes, and perfectly square with the frame on each side. Now see that the distances from the main centers to the top of the engine frames are equal on each side of the engine. To ascertain this, use a small tool shown in Fig. 1, page 39, made of $\frac{1}{2}''$ steel. (See Fig. 2 for dimensions). Place the driver so that a spoke will be in a perpendicular position, and directly in line with the center of the spring saddle, then pass a leg of the tool mentioned on each side of the spoke and saddle. Hold the flat side of the legs firmly on top of the frame and set the pointer to the main center; now

remove the gauge without disturbing the pointer and try the other side. In case the two distances are not the same raise the low side of the engine until they are the same, then prick-punch the back edge of the straight-edge you have clamped forward of the tumbling shaft

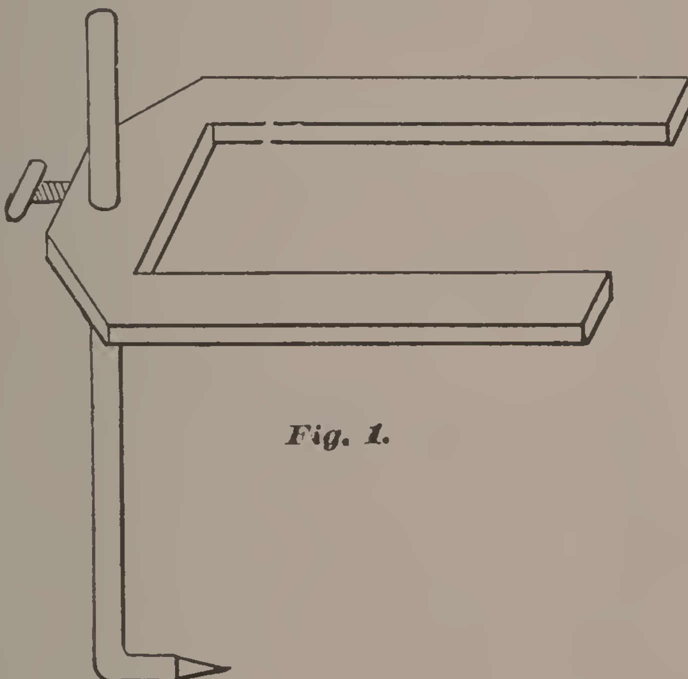


Fig. 1.

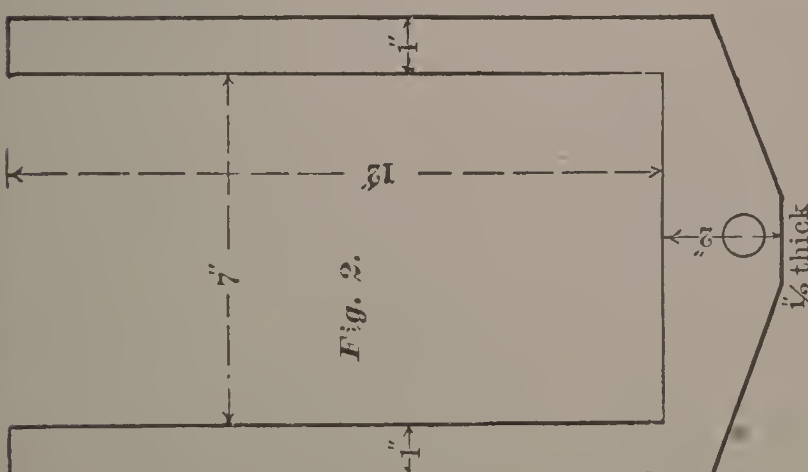


Fig. 2.

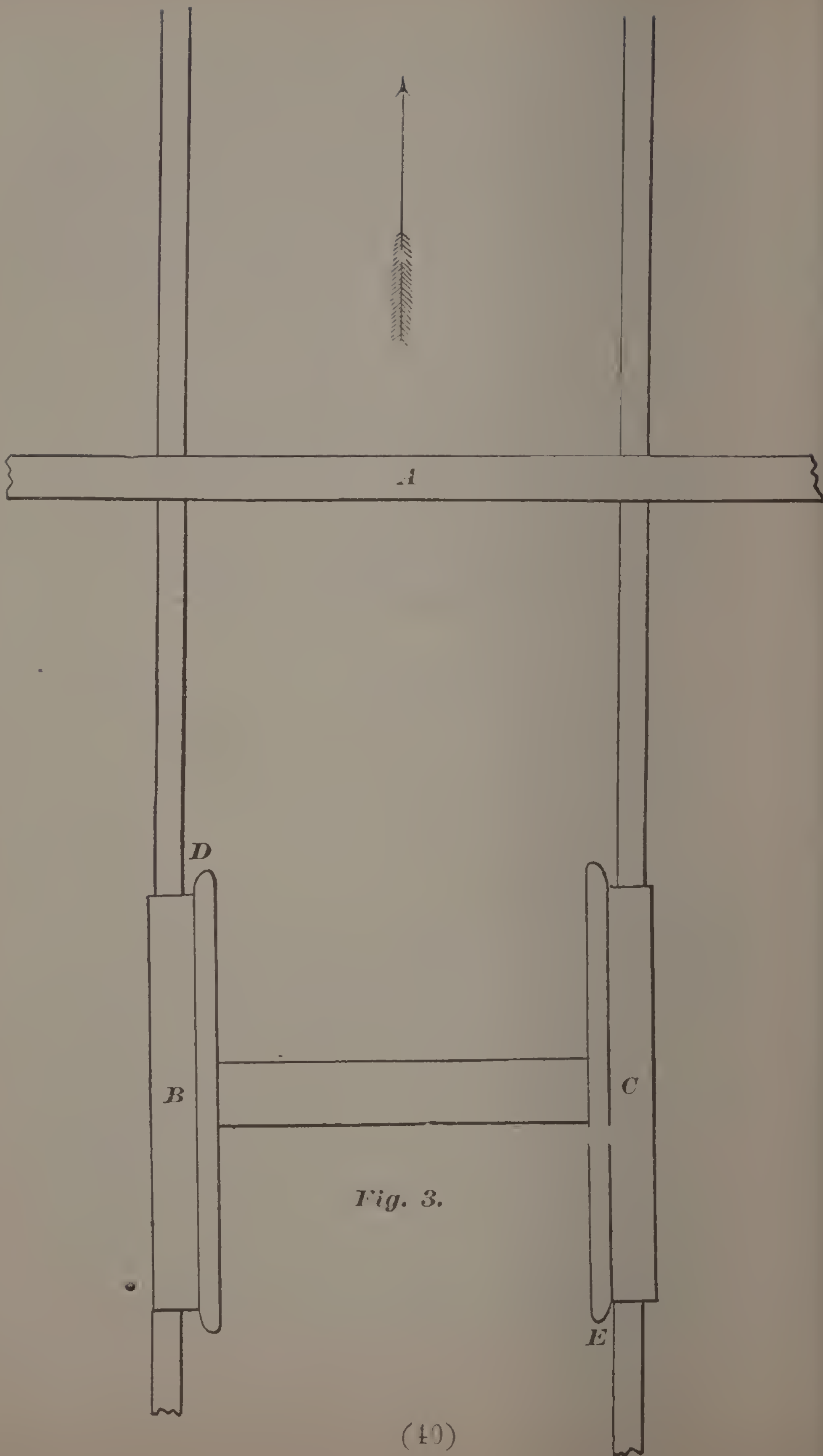


Fig. 3.

boxes an equal distance outside of each frame, and from these punch marks tram to the center of the forward driving wheels, and I think that you will find the center of the driving wheel having the cut flange farther from the straight-edge than that of the opposite driver. Perchance this can more readily be understood by reference to cut, page 40, representing in an exaggerated manner the position of a pair of drivers under the conditions mentioned. The forward part of the engine being indicated by the dart, the straight-edge *A* clamped to the frames. Now if wheel *B* is farther from the straight-edge, when placed as described, than is wheel *C*, the flange of wheel *B* will be crowded to the rail at point *D* when the engine is moving forward, and the flange of wheel *C* will hug the rail at point *E* when the engine is running backward; but as engines usually run forward more than backward the left drivers in the case under consideration would show the greater amount of flange wear. To remedy the evil, either the right drivers must be thrown back, or the left wheel forward, to bring a line through their centers parallel with the straight-edge, and a good way to proceed is to either remove liner from the left shoe or to plane from the face of it about two-thirds the amount that the wheel center shows out with the straight-edge. Then add to the wedge the same amount of liner that was either planed from the face of the shoe or was taken from it by the removal of liner. Now if the distance between the forward and back drivers were the same on both sides of the engine, this same operation must be performed with the left back shoe and wedge; this will bring the drivers again in tram, and both pairs will be square with the engine frames, and I think would give no more trouble.

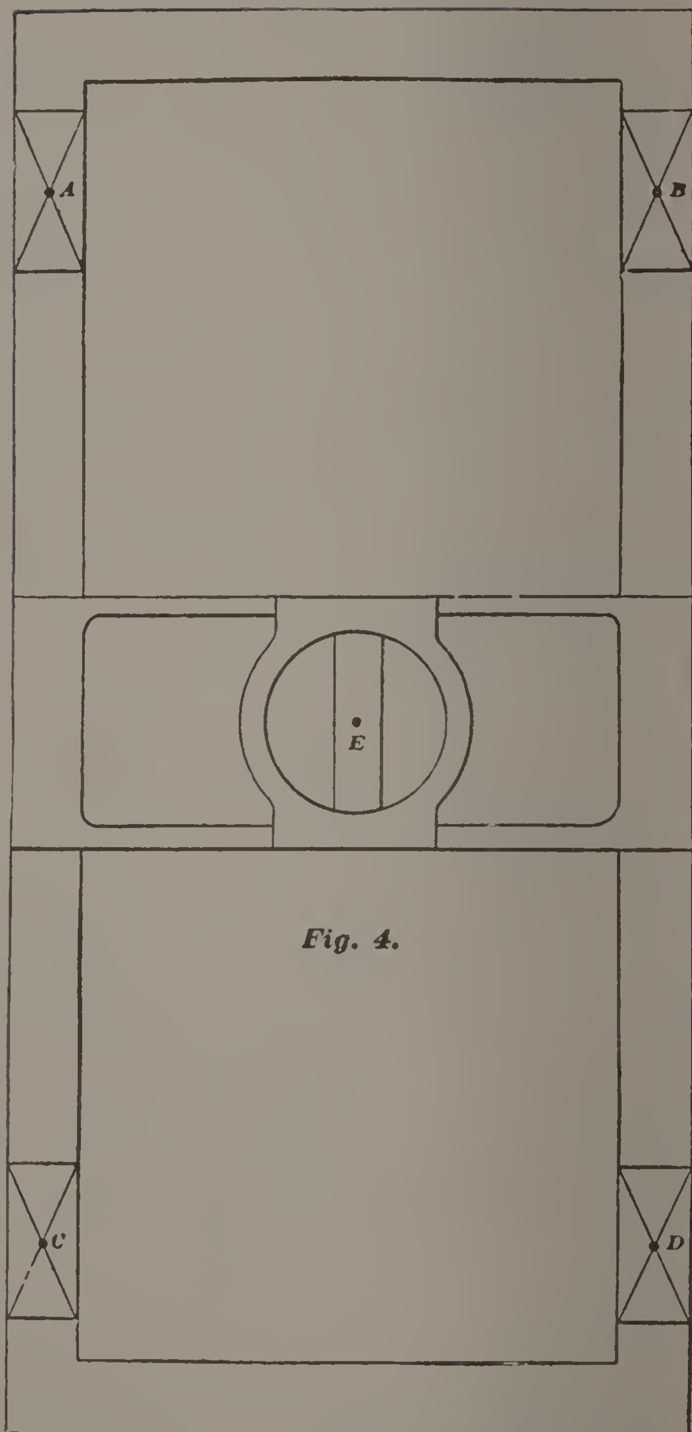


Fig. 4.

Should the engine truck wheel flanges begin cutting, see that the engine truck springs hold the forward part of the engine level, and that the male center casting is centrally located between the engine frames, as previously mentioned. If so, take off the pilot and run the truck out. If it is a truck with a swinging center casting, place a piece of thin board tightly within the casting, and on this board get the exact center of the casting. Now drop the binders and jack up the frame until the bottom of the jaws is nearly to the top of the boxes. Then scribe on top of the frame the face line of each jaw. This may be done by the use of three short straight-edges. Next place the center casting in an exact central position between the ends and sides of the truck frame. Now, referring to cut on page 42, see that the distances from the points *A* to *E*, *B* to *E*, *C* to *E* and *D* to *E* are equal. If they are not equal it shows that either the jaws are not bolted to the frame in the proper positions, or that the truck frame is not square, and one or both pairs of truck wheels are not square with the frame, producing the same evil which exists with the pair of drivers represented by cut, page 40, and means should be taken to make the distances from central point *E* to the center of the truck-boxes equal. After this is accomplished, ask the master mechanic to allow you to block the casting in this position; the results obtained from thus blocking it would, I believe, be very gratifying to you both.

If the trucks under tenders are squared in the manner just described, and the tenders are kept level on their springs, and away from the side bearings, I think that there will be very little trouble caused by the wheels having sharp flanges.

CHAPTER VI.

SHOES AND WEDGES.

The subject of shoes and wedges in a general way might, perchance, come more properly under the head of general repairs, or back shop repairs, as it is quite frequently expressed.

However, it often occurs that work comes into the roundhouse which makes it necessary that the man who does the work should have a thorough knowledge of a correct way to line and fit up shoes and wedges, as practiced in the machine shop where engines go for general repairs. Right here let me say that I consider it a mistaken idea to suppose that most any kind of a workman is good enough for the roundhouse, as the class of workmen seen in some roundhouses would seem to indicate, for there is scarcely a day passes which does not bring to the roundhouses work which, if done quickly and in a proper manner, requires the brightest and best mechanics obtainable.

We will suppose that an engine with a broken driving brass comes into the roundhouse for repairs, and after the drivers are removed it may be found that the shoes, wedges and boxes are cut so badly as to necessitate facing. In a case of this kind it certainly would not pay to put in the driving brass and not repair the shoes and wedges. After having removed the boxes, and gotten the work started on the brasses, the attention should be directed to the shoes and wedges. There is a diversity

of opinion in regard to the best way of lining these up, some claiming that they should be lined square with lines placed through the centers of the cylinders. Others say that it is better to work from the male engine truck center casting. I have observed that better results follow working in the last mentioned manner, provided that the male center casting is in an exact central position between the engine frames. The reason for this belief I will explain further on.

The first thing to be considered when starting to line up a set of shoes and wedges is the condition of the pedestal braces, and should these braces be bolted to the jaws as are those of the Baldwin and several other builds of engines, they should be bolted to place after the removal of the driving boxes, and care be taken that the slots in the braces closely fit the pedestals, or ends of the jaws. In case they do not fit they should be heated and the slots closed sufficiently to allow fitting with a coarse file. I consider it good policy to leave about $\frac{1}{32}''$ space between the pedestals and bottoms of slots in brace after the brace has been drawn tight. This will allow the brace to again be drawn tight in case there is any wear on the sides of the slots in the braces. After the braces are fitted remove the driving springs and saddles, have the engine frames nicely cleaned, and give the face of each jaw a general bearing to a true surface plate. Now see that the center casting is centrally located between the engine frames. Should the shoes and wedges have liners in them they should be removed, and each shoe and wedge be placed in its proper position on the jaws, leaving the bottom of each wedge stand away from the pedestal brace about $\frac{1}{4}''$, and block firmly each shoe and

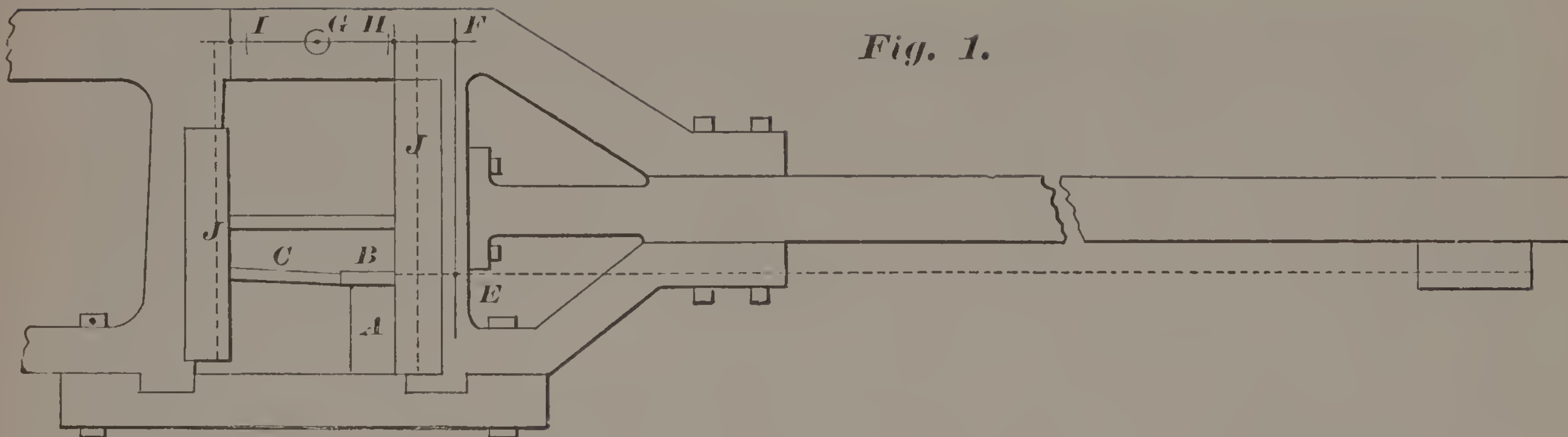


Fig. 1.

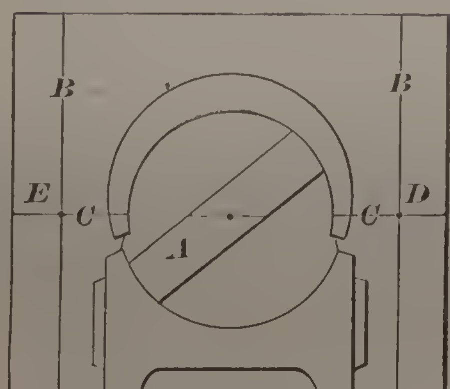


Fig. 3.

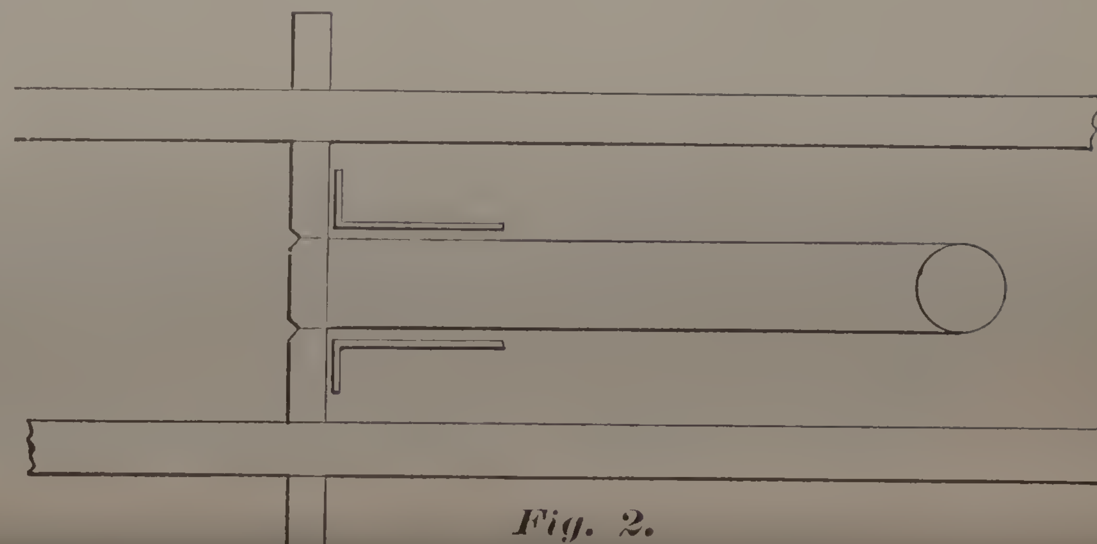


Fig. 2.

wedge to the face of the jaw. Now take two blocks of wood each about 2″x4″ (*A*. Fig. 1), and of such length that, when they are placed in an upright position, one on each forward pedestal brace, their upper ends will be about on a level with the bottom of the center casting. On top of these blocks place flatwise a true wooden straight edge *B*, and block its edge firmly against the faces of the shoes with stick *C*. On the upper surface of straight edge get the exact central point between the engine frames, and using this point as a center, lay off the diameter of the center casting *D*, and notch the back edge of straight edge where these lines come. Then clean off the bottom part of the center casting and pass a fine line around it, and carry the ends back to the straight edge, tie a light weight to each end, and drop the lines into the notches mentioned. (See Fig. 2). Now see if the straight edge is square with each line. If it is not square with the lines, shims should be placed between one end of the straight edge and face of shoe until it comes square.

When shoes and wedges are squared from lines running through the centers of the cylinders the straight edge is used as just described. The difficulty which arises is that the cylinders are very seldom exactly in line with the engine frames, and where they are not it is impossible to get the straight edge square with both lines, and where an effort is made to do so, and the shoes and wedges are lined from the straight edge in this position, the drivers are not square with the engine frames and center casting. This will cause flange wear to driving and engine truck wheels. Then the latter method requires more labor, for it necessitates the removal of both pistons.

Now to return to our line around the center casting. When the straight edge is perfectly square with both lines make a prick-punch mark *E*, Fig. 1, on the outside of the forward jaw on each side of the engine, an equal distance from the face of straight edge and top of the frames, and with a pair of trams transfer these punch marks to the same points on the back jaws Now through the first punch marks made scribe a line to, and square with the top of frames. Then scribe the face line of each shoe and wedge to the top of the frames, and at an equal distance from the top of each frame get the central point between the face lines and see if these central points are equally distant from the lines first scribed to top of frames. That is, see if the distances from lines *F* to points *G*, Fig. 1, are the same on each side of the engine. In case they are not equal, change the central points until they are equal.

After these central points on the forward jaws are placed exactly in line with the straight edge as described, and the central points between the face lines of the back shoes and wedges have been made, tram from the forward to back points on each side; the back points may have to be slightly changed to make these distances equal. The boxes should now be fitted to the journals, after which place a piece of wood *A*, Fig. 3, firmly between the brass and cellar, flush with the sides which bear against the wheel hubs when the boxes are in place. On these pieces of wood get the centers of the brasses, and transfer the shoe and wedge bearing faces of each box to the outside faces by scribing lines *B B*. Now scribe line *C* squarely across the last two lines, and passing through the center mark on the piece of wood. Fig. 3 represents

the outside face of the right forward box. With a pair of dividers now space the distance from the center mark to punch mark *D*, and scribe this on the frame towards point *F*, using point G as a center. The distance from face line of shoe to line *H* (the last one made), with what is needed planed from face of shoe to true it up, is the amount of liner required for that shoe. It is a good plan to write on the frame above each shoe and wedge the amount of liner each requires as each amount is ascertained. By so doing, all liners may be cut out at the same time.

When finding the amount of liner required for the opposite shoe, care must be taken to space the distance from the center mark to punch mark *E* on the left forward box. After the amount of liner for the shoe has been found, space with the dividers, the distance from punch marks *D* to *E*, and using as a center the intersection of horizontal line *H*, Fig. 1, scribe line *I;* the distance from face line of wedge to the line *I*, together with what the wedge requires planed from face to true it up, is the amount of liner needed for that wedge.

After finding the amount of liner required for each shoe and wedge, take them down, cut out and fit each liner where it belongs; now replace the shoes and wedges on the jaws with the liners in them but not riveted, and place the straight edge in its former position; be very sure now that the distance from mark *E* to the straight edge is equal on each side, then scribe the lines *J J* down the frame and outside flange of each shoe and wedge, square with the top of frame. This mark should be made near enough to the face of each shoe and wedge to insure it being seen by the planer hand should he hold

them in a chuck on the planer. Now with a pair of morphrodite calipers get the distance from the straight edge to lines *J* on the shoes, and scribe it from the straight edge on the inside flange of each shoe, then set the points of a pair of dividers to the lines *J J*, and taking the lines on the inside flange of the shoes for centers, scribe a line on the inside flange of each wedge, remove the straight edge now from the forward jaws, and block it to the shoes on the back jaws, and see that the distance is the same on each side from the straight edge to the marks which were transferred from the forward to the back jaws. Then from the straight edge lay off the inside of each back shoe, and wedge in exactly the same manner as just described for the forward ones. Now if each shoe and wedge is chucked on the planer to mark *J*, and mark on inside flange when finished, and then put in their places on the jaws, their faces will be square with the top of frames and the lines from the center casting. To insure that no more be planed from the faces than necessary, the distance should be given the planer hand from line *H* to *J* for each shoe, and from *I* to *J* for each wedge, and after the planing is done, lines *J* remain as proof lines, and will show whether the planing has been properly done or otherwise. After each shoe and wedge is planed, replace the liners in each just as they were when they were laid off, and rivet them there, using but two rivets near the top of each; liners riveted in this manner will not buckle as they will when more rivets are used.

After the liners are all riveted in, place each shoe and wedge in its proper position on the jaws, and block them firmly to face of jaws, and try if their faces are flush

with lines *H* and *I*, are square with the top of frames, and parallel with each other; if so, give each a general bearing with a file to a true face-plate (use no scraper), after which true the shoe and wedge bearing faces of each box, using as a face-plate each shoe and wedge where it belongs in the box; they are then ready for service. If the directions as given are closely followed it will not be necessary to try the boxes in the jaws previous to wheeling the engine, and the wedges can be adjusted after the wheels are in place.

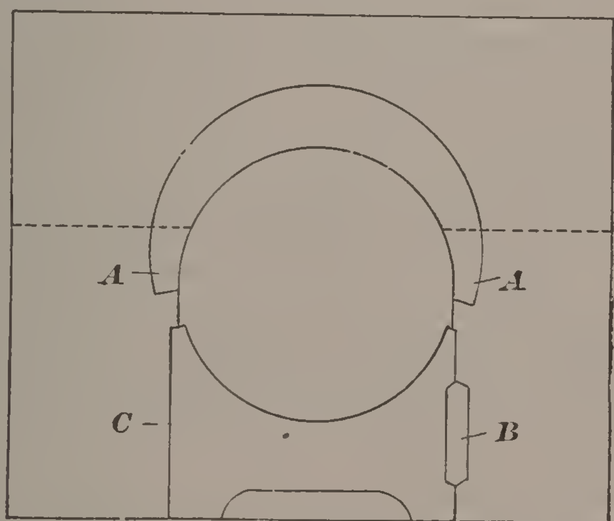
CHAPTER VII.

DRIVING-BOXES.

When an engine is undergoing general repairs, special attention should be given to the driving-boxes and driving-brasses, to see that they are fitted up in first-class order. If any part of the work is slighted do not let these parts come in for their share, for nothing is more discouraging to a good engineer than to have his engine pound in the driving-boxes and brasses, and a renewal is the only remedy where the brass is too large for the journal, and if the box closes, or the wedge is not the proper taper, the play of the box between the shoe and wedge cannot be taken up by setting up the wedge. These evils can be overcome only by removing the box, which necessitates trouble and expense.

Some engineers, and foremen too, for that matter, in cases of this kind advocate planing the wedge until it has the proper taper to overcome the play of the box between the shoe and wedge. This I consider poor policy, for reasons which I will hereafter give. When an engine comes into the machine shop for general repairs, after having been in service for two or three years, the driving-boxes, shoes and wedges are in a majority of cases very much in need of repairs; the shoes and wedges need lining and facing, the boxes will need planing, and the brasses will generally require renewing, or in case they are heavy enough they will be too large for the journals, or be loose in the box. When there

is plenty of material in the brasses, and they are too large for the journals and loose in the boxes, it sometimes pays (when everything else is equal) to shim the brasses tight in the boxes, this will also close them to the journals, but in most cases this shimming does not pay. I think that the better plan is to put in new brasses while the opportunity is offered. Where the brasses to be renewed are of a solid pattern, in the form of a half circle, the box should first be planed out to a true circle, leaving



the distances from the crown to the points *A A* (see cut), about $\frac{1}{16}$ inch greater on the side which is to go next to the hub of the driver; this will prevent the brass from working out of the box, should it become slightly loose, and this distance should be great enough to allow that part of the brass which rests in the points *A A* to be from $\frac{3}{4}$ inch to 1 inch below the center after the brass is bored to the required size. The outside of the brass should now be either planed in the slotter, or turned to the size that

the box was finished, then the brass may be fitted to the box by planing from the edges which are to bear in the points *A A* a sufficient amount to allow the brass to go into the box the last inch at about twenty tons pressure; this will generally spread the bottom part of the box about $\frac{1}{16}$ inch. Now, at about the point represented by the dotted lines, and centrally between the flanges, bore a one-inch hole through box and brass on each side, and into these holes put brass plugs, making a good driving fit. The brasses should now be bored out to fit the journals before the cellars are fitted into the boxes. Boring the brasses generally allows the bottom of the boxes to close about $\frac{1}{32}$ inch, if the brass is put in under the pressure mentioned, and this leaves the top of box $\frac{1}{32}$ inch narrower than the bottom part; this causes the part which contains the cellar to be a trifle wider at the bottom than at the top, provided that the sides of this opening were originally planed parallel; this makes the removal of the cellar easy after it is started, even if it is very tight when up to place.

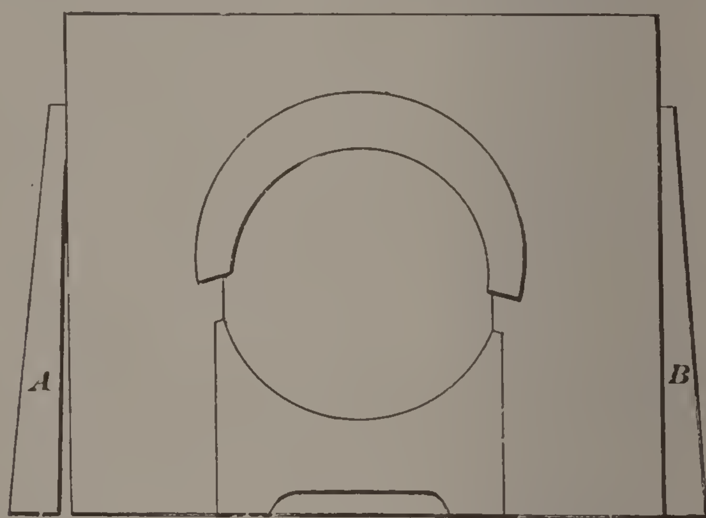
Some builders cast the boxes with a slot across the sides of the openings which contain the cellars, and in some cases these slots are also cast in the cellars. When the cellars are in place this leaves openings from side to side of the boxes, as shown at *B* (see cut), and a rib at top and bottom of both box and cellars. I do not like this plan, for in replacing a cellar the top will strike against the bottom of the top rib on the box, if the cellar tips in the least A good way to overcome this evil is to plane out about $1\frac{1}{2}$ inch wide from each end of each rib on cellars and boxes, liners can then be riveted on, of the required thickness to make the cellars tight in the boxes,

and both sides of the cellars and boxes will appear as shown at *C*, and the cellars will be sure to go straight to their places, if entered properly. Now, fit the brasses to the journals, being careful to make that part which comes below the center of the journal, when the box is in place, exactly the size that the journal is in diameter.

After the brass has been brought to a general bearing on the journal, I think it a good practice to file from the crown a place about $1\frac{1}{2}$ inch wide and $\frac{1}{32}$ inch deep; this insures a good bearing on the sides to start with; after the brasses fit the cellars, and they being $\frac{1}{32}$ inch taper will go nearly up to their places before becoming tight, they should be fitted tight enough so that when they are up to their places the box cannot close a particle, and still not be tight enough to spread the box. Now, with the cellars in place, plane the shoe, and wedge bearing faces of the boxes, leaving each side an equal distance from the center of the brass, and perfectly parallel with each other.

Now, a word in regard to not being able to take up the lost motion of boxes between the shoes and wedges by setting the wedges up. As previously mentioned, the cause of this trouble is that either the shoes and wedges have not been planed parallel, or that the shoe and wedge bearing faces of the box are not parallel; the latter is generally the case. Now, if a brass is pressed into a box at twenty tons pressure, and the shoe and wedge bearing faces are planed before the brass is bored out, or the cellars fitted, when the brass is bored out the bottom of the box will close; this throws the planed faces out of parallel, and the box is in the condition represented in an exaggerated manner by cut, p. 56, and if the wedge has been planed square with the top of frame it will stand in the

position shown at *A*, and any attempt to set it up will cause it to strike between the box and frame at the top, leaving the bottom loose, and, if the top is planed off to fit the box, it will be as shown at *B*, and the box cannot work freely between the shoe and wedge. Should a driving spring become weak, and let the frame down a little, the box will pound between the shoe and wedge, and should any unevenness in the track cause the box to low-



er, it will stick. But boxes sometimes get into the condition just described when the shoe and wedge bearing faces were parallel when the engine was first turned out of the shop, and this is owing to the cellar not having been fitted in the proper manner at the start, or having been filed smaller by some roundhouse man the first time the box was packed after going into service. I have heard of men reducing the cellars after the engine came out of the machine shop, so that they would not have so much trouble while packing them. This I consider very poor

policy, for this reason: As the brass wears, the tendency of the box is to close in at the bottom, if it has been put in under sufficient pressure to hold it tight in the box, and when the cellar is loose the box closes to it, and the evils described are produced.

Allowing a driving-brass to run hot is a more serious thing than some engineers appear to realize, for it is sometimes, and where it becomes very hot it is in a majority of cases, followed by evils which can only be remedied by the removal of the box. The trouble referred to is the journal boring out the brass, and is produced as follows: The first things to become heated are the journal and brass. When heated, they expand; the box, being cold, does not expand, and is held tightly between the shoe and wedge, if properly fitted up, and does not give as the journal expands; the consequence is that the journal cuts its way in the brass until it has become free. Most engineers will remember that in most instances of hot driving-boxes small particles of brass will be seen, which have worked out from between the box and the wheel hub. When the journal cools off it will resume its original size; the brass is then too large, and the journal will pound from side to side when the engine is working hard; but some one may say, "When a driving-brass heats and expands, the box will stick between the shoe and wedge, and a good engineer will at once pull the wedge down a little, to allow the box to work freely." True, he may do this, but this does not prevent the journal and brass expanding faster than the box, in which case the journal is sure to cut its way in the brass.

In some shops they take up the lateral motion caused by the faces of the boxes against the wheel hubs by plan-

ing from the inside flange of each shoe and wedge where it bears on the jaw, and putting a liner on the outside flange; this crowds the box towards the hub face, and takes up the lateral motion, but at the same time the size of the shoe and wedge has been thrown out of standard, and the spring saddle will not stand an equal distance from the inside and outside of the frame. I think that care should at all times be taken to keep all parts to a standard size, for where this is not done it causes much trouble where many engines are to be kept in repair. A better way to do in the case cited would be to measure the distance between the driver hubs, and from outside to outside of engine frames, and find whether the wear was from the face of the box or from the driver hubs. The liner should then be put where needed to keep all parts to standard dimensions. This is best, I think, even if the face of the box has to be planed off, or that of the wheel hub turned to allow for a liner of sufficient thickness to warrant it remaining in place.

While speaking of liners for this purpose, I will say that I have seen very good results follow facing the hubs of engine truck and driving-wheels, and also the faces of the driving-boxes with babbitt metal, and the difference in labor would, I think, make the use of this metal cheaper than turning and riveting on brass plates.

CHAPTER VIII.

WASHING BOILERS.

One of the most important parts of roundhouse work is the regular and thorough washing of locomotive boilers. There is no part of a locomotive which should have more care and attention, but at the same time there is no part of an engine which is so liable to be overlooked and injured as the boiler. To insure the boilers being regularly washed, some means should be taken by which a correct record can be kept of each time a boiler is washed. A very good way to do this is to give the boiler washer a book in which to put the date each boiler is washed. At the end of each week he can present his book to the roundhouse foreman, who may from it make a weekly report to the master mechanic, giving the number of each engine, and date the boiler was washed. These reports could be placed on file for reference. By referring to a book kept in this manner the boiler washer could wash each boiler after a lapse of any specified time, and if an engine came in which did not run regularly into the roundhouse where he worked, he could wash it, and keep a record of it, for boilers are more liable to be neglected than washed too often. The length of time a boiler should be allowed to run before washing depends materially upon the locality in which the engine runs. Those running in localities where the water contains but little sulphate and carbonate of lime need not be washed but about once in two weeks, but where

the water used contains ingredients which produce hard scale, the boiler should not be allowed to go longer than one week without washing; and I have seen water used which produced scale so rapidly that it was very necessary to wash the boiler after each trip. To obtain the best results, hot water should be used while washing a boiler, for the reasons that hot water will more readily remove scale, and it is not so injurious to the boiler as cold water. Cold water thrown into a hot boiler produces sudden contraction, and consequent strain upon all parts. In cases where steam cannot be had for heating the water, and the time for washing is limited, a good way to proceed is to blow the steam off, and run in cold water until the boiler is completely full, then open the blow-off cock and allow the hot water to run out but little faster than the cold water is forced in; in this way the boiler can be cooled quite rapidly, and sudden contraction be avoided. After the boiler is comparatively cool, wash with not less than 100 pounds pressure. A good way to provide hot water for washing purposes is to run a permanent steam pipe through the roundhouse from the pumping or stationary boiler; if the house is heated with steam this pipe may lay in the pit with the heater pipes, but a better way is to place it at a sufficient height from the floor to clear the engine's stacks, for by this means less trouble will occur from condensation. Branch steam pipes should be put in from this main pipe to each hydrant; connect as shown by Fig. 1. Take a gas pipe tee, one end and the side opening of which is the size that the water stand pipe calls for; the other end should be the size desired for the branch steam pipe, and this pipe should be one size

smaller than the main pipe from the boiler. Now take a piece of pipe the size of the smaller end of the tee, and swedge down one end as represented by Fig. 2; the diameter of the openings in the ends of this pipe should be in about the proportion of $\frac{5}{8}''$ to $1\frac{1}{2}''$; cut thread enough on the larger end to take a check nut and elbow after it is screwed through the smaller end of the tee

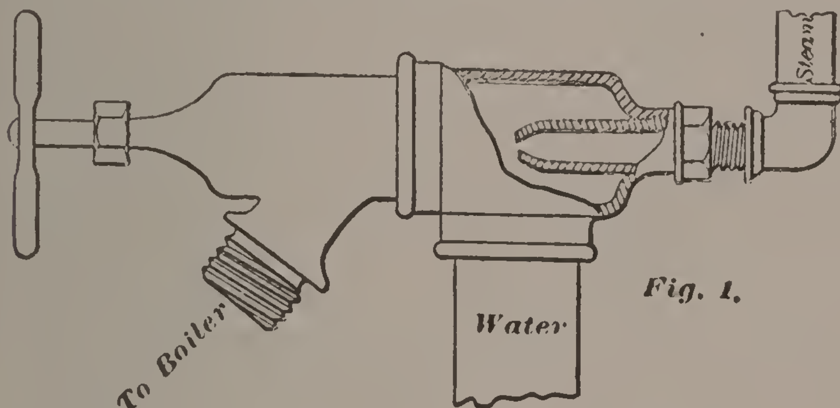


Fig. 1.

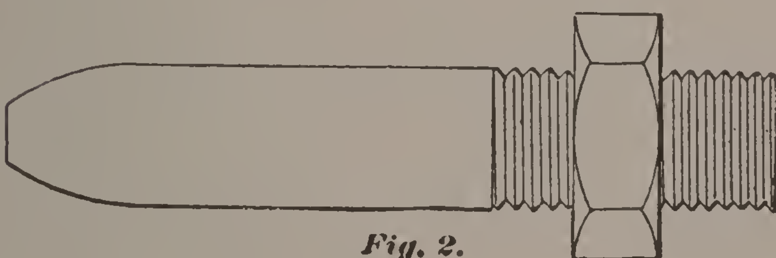


Fig. 2.

from the inside. When in position the small end of this nozzle should be in line with the center of the water pipe, as shown in Fig. 1. Attach the tee to the hydrant pipe at the side opening, and put the hydrant cock in the opposite end from the steam nozzle. A globe valve, should be put in the water pipe below the tee, by means of which the water supply can be regulated. With this arrangement good results may be obtained with from 80

pounds to 90 pounds steam pressure, and after the washing is completed the boiler can be filled with hot water, which will facilitate matters where the engine is wanted for immediate use.

When washing a boiler not provided with a mud drum or hand hole in the bottom of front sheet of shell, the washout plugs should always be removed from the front flue sheet, but where the boiler is equipped with the appliances mentioned the removal of the flue sheet plugs is not so essential. All other plugs and hand hole plates should be removed each time the boiler is washed, and I consider it a good plan to remove the steam dome cap, also, for by thus doing incrustation can be loosened from the crown sheet, bars, and braces; the stream of water can be thrown directly on top of the crown sheet; this will wash the scale into the boiler legs, from whence it can be removed through the hand holes.

When the washing is completed it is a good plan to ignite a piece of greasy waste, fastened to the end of a rod of sufficient length that the burning waste can be passed through the hand holes in the corners of fire-box, and every part of the side, back, and flue sheets be examined to be sure that every particle of deposit is removed from them and the mud ring. A torch of this kind should also be passed through the plug holes in the boiler head, the top of crown sheet and space between the crown bars can thus be examined.

When preparing a boiler for service, after having been washed, care should be taken to keep a bright hot fire until steam is generated; this produces rapid circulation, and scale will not form so rapidly under these circumstances as when the water is heated slowly. I have seen

boilers filled with cold water, and then charged with steam from another engine by the use of a steam hose, so that the blower could be used. This is a very bad practice, for the reason that, under these circumstances, the upper part of the boiler is hot, while the lower part is cool; this produces unequal expansion, and strains the seams and stay bolts.

When a roundhouse is equipped with the appliance for heating the water as described, and the time for washing and preparing the boiler for service is limited, the blower may be worked by using a tee connection in the blower pipe where it enters the smoke arch, and making connection between this tee and the steam pipe which connects to the hydrant. The boiler being warm and full of hot water, will not be seriously injured by the use of the blower under these circumstances, for the reason that it is not subjected to the influence of heat other than that which comes from the fire-box. About the only objection which can be given to the use of the blower as described is the rapid expansion of the tubes, but the boiler and water being warm, I do not think that this rapid expansion would be productive of serious evil, and I know that it would meet the approval of some of our "hurry up" train dispatchers.

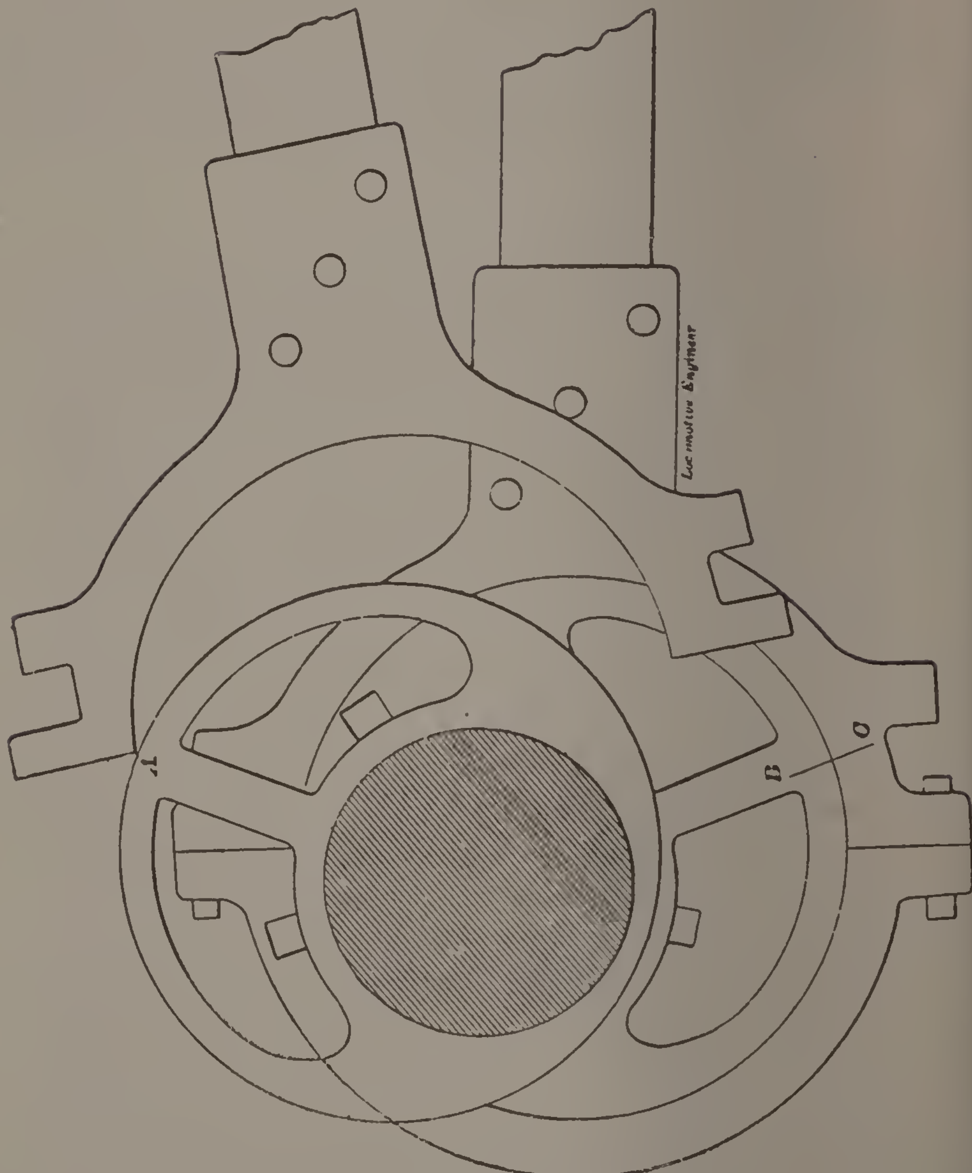
A word here in regard to the care of boilers may not be inappropriate. I would say to the roundhouse foremen, be particularly watchful of the engine dispatchers, or hostlers, as they are oftentimes called. See that they move the engines as little as possible after the fires are shaken out, for each exhaust draws cold air into the fire-box, and through the tubes, causing sudden contraction and consequent injury. Never allow cold water to be

injected after the fire is removed, for by injecting cold water into a hot boiler not under fire, all parts of the boiler are subjected to chilling, and the evil results attending sudden contraction are produced.

CHAPTER IX.

MOVING ECCENTRICS.

The distance an eccentric should be moved on the shaft depends materially on how much throw the eccentric has, and on the length of the rocker arms. Different builders making a wide difference in the dimensions of these parts renders the application of any rule to all engines impracticable. Assuming that the back motion eccentrics are outside, next to the driving-boxes, and also that the eccentrics are not keyed to the shaft, I should proceed as follows: Now this may be called by some a "cut-and-try" way of working, but I think it a quicker way than to endeavor to figure out a rule to apply to a particular engine. After having given the engine the desired amount of lead in the forward motion, I would place the reverse lever in the extreme back notch of quadrant, then pinch the engine backward and catch the forward dead center; then take down the back half of the forward eccentric strap, and push the forward half with the rod as far forward as possible. The top part of the strap would then be resting on the eccentric at about the point *A*, (see cut); in this position the set-screws in the back eccentric may be reached. Now, before slacking off these set-screws, scratch a good plain line *B C* across the lower part of the back eccentric and strap. Now as the eccentric is moved on the shaft the lines *B C* will separate, and on most engines the proportion of the distance these lines will sepa-



rate to the distance the valve stem will move is about 5 to 1; thus, if the valve stem is to be moved $\frac{1}{16}''$ the lines *B C* should be separated $\frac{5}{16}''$; but, as I have stated, no rule will apply to all engines, and this proportion will

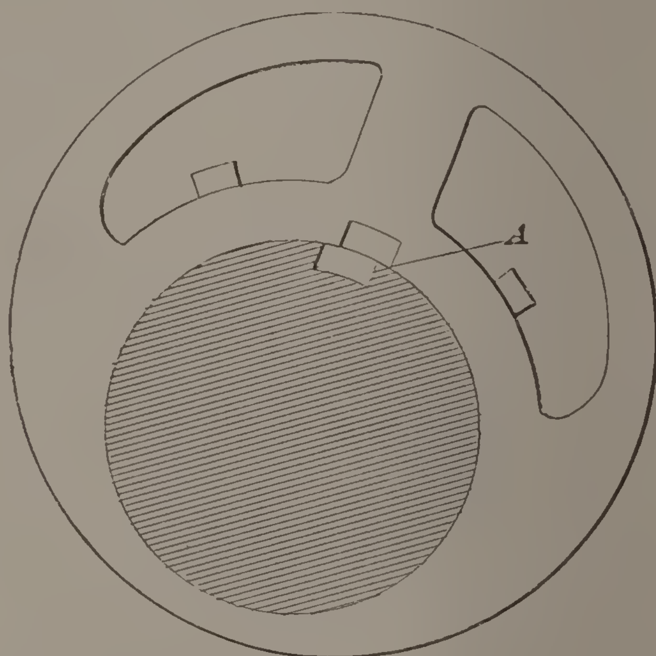
change as the outside diameter of the eccentric cam decreases by wear.

After having separated the lines *B C* five times the amount of lead I desired, I should replace the back half of the forward strap, and pinch the engine forward nearly one-half revolution; then by pinching the engine back would again catch the forward center, and note the lead obtained; by carefully noting the amount of lead produced by separating the lines *B C* a given distance, the exact lead could be given at the second trial, if necessary to move the eccentric the second time; then if I was running the engine regularly, and was expected to keep its valves square, I would write down, and keep in a handy place for reference, the proportion of the separation of the lines to the lead produced. It was one of my duties at one time to set the valves of all engines turned out of the Brainerd shops of the N. P. R. R., and to facilitate my work I kept a table of these proportions as required for the different builds of engines. Thus:

Baldwin's =	line	separation	5	times	the lead	produced.	
Hinkley's =	"	"	4¾	"	"	"	"
Rome's =	"	"	5¼	"	"	"	"

I do not give this as a correct table, but only to show the manner of keeping it. These tables were made, of course, after having obtained the proper proportion by trial. By this scheme I could give those eccentrics next to the driving-boxes the desired amount of lead eight times out of ten by one trial. A word now in regard to moving eccentrics which are keyed to the shaft. When I was doing this class of work I desired the gang boss in the machine shop to place the eccentrics on the shaft.

so that the keyways in the cams came exactly in line with those in the shaft, and hold them in place with the set-screws, leaving out the keys. After getting the eccentric rods the proper lengths, I would move the inside eccentrics to produce the desired lead, then move those next to the driving boxes in the manner here described. After all were in their proper positions the keyways in most instances would appear similar to those represented



by cut. I would then take a small, thin wedge of soft wood about one-quarter the width of the keyway, and place the edge of it against the side of the keyway in the eccentric, then by lowering it bring the thin end in contact with the lip *A* on the shaft; by rubbing it forward and backward a few times under a slight pressure a clear impression of the width of the lip is made on

the wedge. This impression shows exactly the amount of off-set required for that key.

If a person is careful after having moved an eccentric to go over the work a second time, to insure its being in the proper position, and makes an accurate measurement of the impression of the lip *A*, and is careful while making the keys, it is but a short job to put in a set of keys, and it will not be necessary to run the engine over in full gear after the keys are in place.

CHAPTER X.

BACK CYLINDER HEAD.

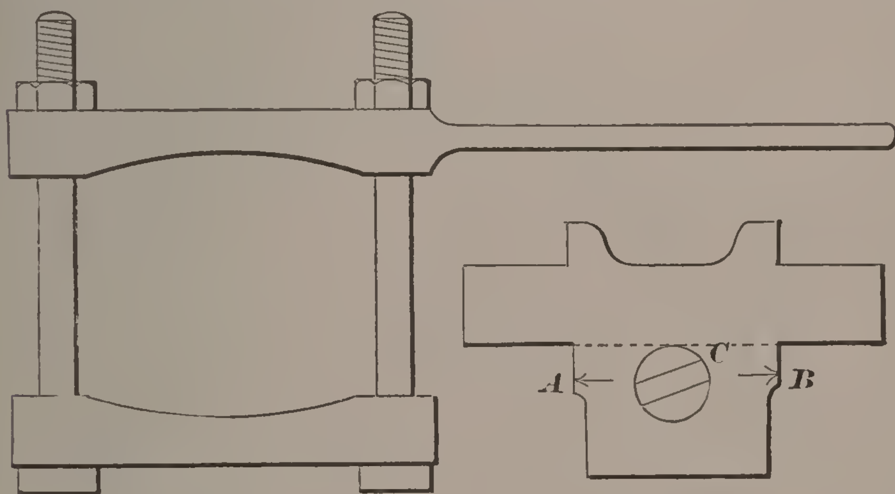
How many of the younger machinists and machinists' apprentices have, I wonder, thought how they would proceed, if given the task of laying out, drilling and putting in place a back cylinder head. Of course this would not be so difficult a job to do if jigs were available, to which the head could be drilled. But all shops do not have jigs, and a machinist may often be called upon to do work of this kind when very few tools are provided.

We will assume that we are working in the roundhouse at some division terminal, where the only machine tools provided are a drill press, a small lathe and planer, and that an engine comes in with the right back cylinder head badly broken. One is sent to us from the main shops, but it is only finished in the lathe and is not drilled for the studs or guide-blocks. How shall we lay it out properly?

Some one may say, "lay it out from the old head," but this is not possible to do in all cases. The old head may have been broken too badly, then too, the old head may not have been properly put up in the first place. The best way I think, is to have ideas of our own relative to these matters; then we are independent.

Now we know that the joints will have to be ground, so we will first remove all of the studs which fastened the head to the cylinder, then with two pieces of wood and two bolts make a clamp (cut, p. 71), and fasten it around

the neck of the cylinder head. Then thread each end of a rod or use a bolt long enough to pass through the cylinder and head, when the head is in place. After applying oil and emery to the joints, fasten the head to place by passing the rod or bolt through a plate of iron, long enough to span the front end of the cylinder, then pass the rod through the cylinder and head, fasten it at the back end by passing it through a plate of iron, of suffi-

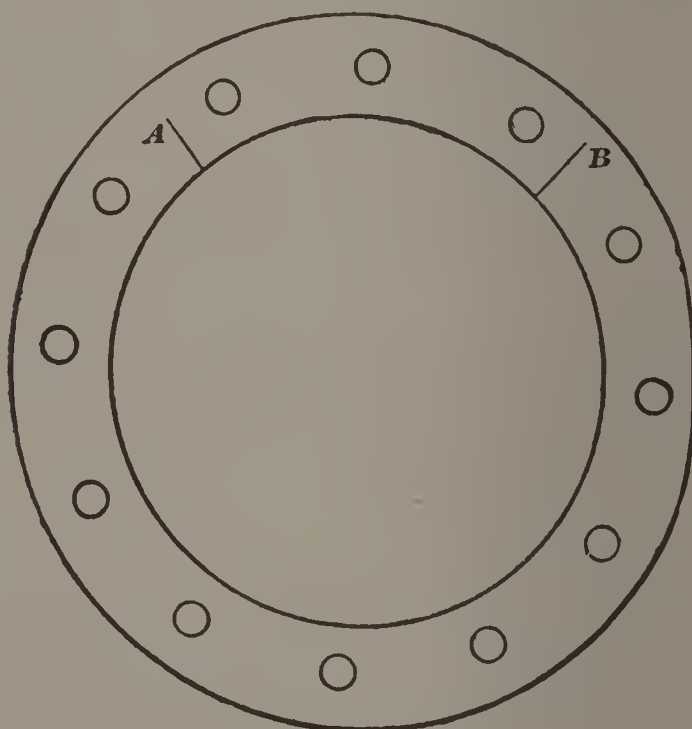


cient length to span the stuffing-box in the head. The head can then be turned and ground by the use of the wooden clamp, previously adjusted. The necessary pressure can be given by tightening the nut on back end of rod.

After the joint is perfect we can easily determine which part of the head should go to the top of the cylinder by the position of the clearance space cast in it, for, with the head in place, this space should conform with the steam port in the cylinder.

Now dampen some lamp black with oil (do not have it too thin) and apply a very light coat of the mixture all

around the inner edge of the joint on the cylinder, also around each stud-hole and outer edge of the flange, and with the lamp black also make two fine lines, *A B* (see cut), across the face of the flange, one at each end of the steam port. Now take a piece of stiff wrapping paper large enough to cover the end of the cylinder, and having the helper hold it firmly to place, rub the surface of the paper with your hand over all points where it touches the flange;



this will give you on the paper a clear impression of all stud-holes, marks *A B*, etc.

Remove the paper now and cut out the center and outer circumference, being careful to cut close to the lines, then with a lead pencil make a dot in the center of each stud-hole impression. Now lay the template on the head,

being careful to lay the side with marks on toward you, and having the lines *A B*, one at each end of clearance space; then have the template held firmly to place while you with a fine center-punch, mark over each pencil dot a punch mark through the template into the head; remove the template and from the punch marks lay out the stud-hole .02″ larger than the studs. Now drill them to the marks, replace the studs and you will find on trial that the head will slip to place nicely.

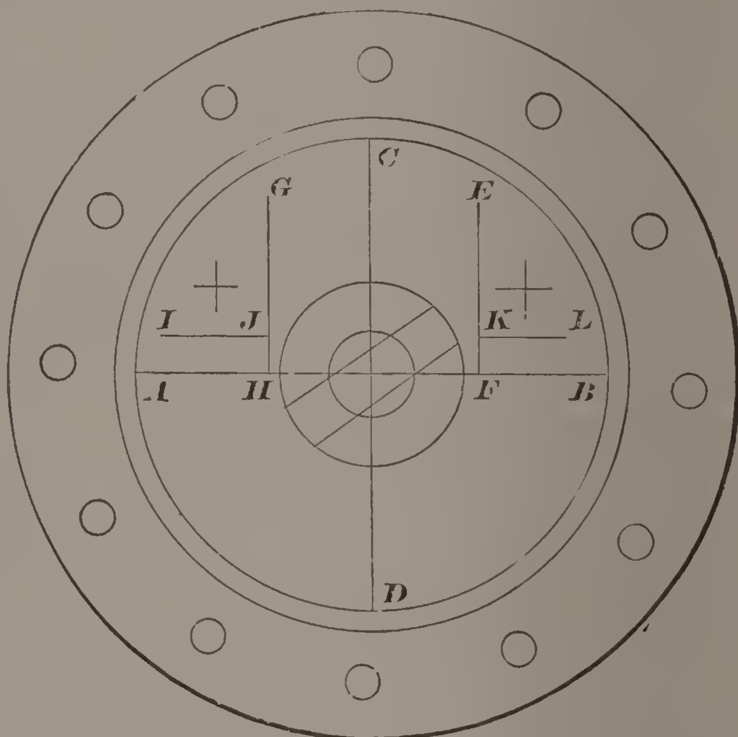
Fasten it to place with a nut at the top, bottom and each side, then on a stick or a piece of flattened copper wire, driven firmly into the stuffing-box, get the center of same. Now place a straight-edge on top of the frames just back of the cylinder, of sufficient length to reach from frame to frame, and to this adjust a level; it does not matter if the engine is not exactly level, if care is taken to adjust the level to the straight-edge.

Fasten the level now on the top of a shorter straight-edge (being very careful not to reverse the level from its former position when adjusted to the long straight edge), and place the short straight-edge with the level on it against the face of cylinder-head flange to which the guides are attached; adjust the straight-edge until the level is correct, and along its top edge, through the center of the stuffing-box, scribe line *A B* (cut, p. 74), and also through the center scribe line, *C D*, at right angles to line *A B*. Those lines now form the foundation from which we will work, for we know that line *A B* is level with the engine and that line, *C D* is plumb with it.

Now the distance that the guide-blocks should be apart on the head might be determined from the position of those in the guide-yoke, but the yoke might also be

broken, and we will consider such to be the case in the present instance, and that the entire head has been renewed, planed up and sent to us without having the holes drilled for the blocks.

We will now turn our attention to the crosshead and must bear in mind that when all parts are in place the



center of the hole into which the piston-rod fits in the crosshead, must be exactly in line with the center of the stuffing-box in cylinder-head. So after centering the hole in crosshead we will span with our dividers from this center point to point *A* (cut, p 71), and from center of stuffing-box (cut, p. 74), mark this distance to the *right* of center on line *A B*; then from this mark scribe line *E F*, par-

allel with line *C D;* now do likewise with distance from center point in crosshead to point *B* (cut, p. 71), and scribe line *G H* (cut, p. 74), parallel with line *C D;* then across the end of the crosshead and just flush with the lower bearing surfaces of each lug scribe dotted line *C* (cut, p. 71), and from the center of hole set the dividers $\frac{1}{32}''$ *above* line *C*. This is to allow for a $\frac{1}{32}''$ liner between each bottom guide and block.

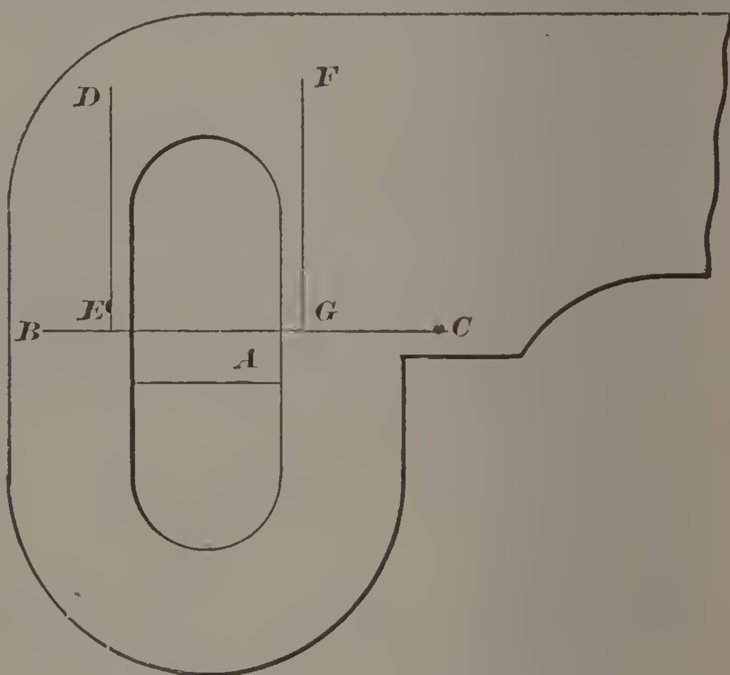
Now from points *F H*, on line *A B* (cut, p. 74), mark this distance on lines *E F*, and *G H*, and from the marks thus made, scribe lines *I J* and *K L*, parallel with line *A B*.

When the blocks are in place their inner edges should be flush with lines *E F* and *G H*, and their lower faces flush with lines *I J* and *K L*. All of the lines should be scribed lightly so they can be filed out after the holes are drilled.

Now mark the top of the outer block, No. 1, and the top of the inner block, No. 2, and from the inner edge of block No. 1, space the distance to the center of the lug by which it was secured to the head, and to the right of line *E F*, and parallel with it, mark this distance. Now get the distance from the bottom surface of the block to center of lug and above and parallel with line *K L*, mark the latter distance on the head. Proceed in like manner with block No. 2, only scribe to the left of line *G H* and above line *I J*. The points of intersection of the four lines last made are the points for the center of the holes for the block lugs, and the holes should be drilled and reamed to warrant a snug driving fit of the block-lugs.

The holes over the piston gland studs can now be located on line *A B* or *C D*, as the case may require, the

head will then be ready to drill; but before removing it we will remove the center stick of the stuffing-box, bolt the yoke to place and run a fine line or wire through the cylinder and secure it to the yoke by hanging a weight to it after passing it over the stick *A* (see cut), driven



firmly into the slot through which the main rod plays; now center the line from the counter-bore in front end of cylinder and stuffing-box in back-head; then with the short straight-edge, with level on it, we will scribe on the forward side of the yoke line *B C*, just flush with the line through the cylinder; then mark on stick *A* a point at which the line through cylinder rests on it; remove the line or wire and proceed to lay out the holes for the back blocks, in exactly the same manner as we did those for the forward block on the head, after which both yoke

and head can be removed and drilled, and before replacing them, after the drilling is done, each block should be fitted to place, for when again put up they should remain in place. When both are finished and bolted to place we are ready to line up the guides.

CHAPTER XI.

GUIDES.

Upon this subject probably but little will be said which will materially aid experienced locomotive mechanics. However this may be, I hope to say something which will prove a benefit to apprentices, and those unaccustomed to this class of work. I have seen machinists who claimed to have had vast experience in these matters who could not, or at least who never did, line up a set of guides which would run cool, and not cause excessive wear to the crosshead.

Before starting to line up a set of guides it is, of course, very necessary to have the bearing surfaces of each crosshead lug planed perfectly straight and parallel, also to have each guide planed or ground true its entire length To true up the crosshead I should proceed as follows:

Place securely in the tapered hole from which the piston-rod was removed, a short mandrel; this mandrel should fit the hole perfectly. Place the head on the planer bed with the top side down to enable the bottom bearing surfaces to be planed first. In some shops they use two V-shaped iron blocks bolted to the planer bed, and clamp the mandrel with the crosshead attached in the V part of the blocks. This is a very good plan, and it insures the surfaces being planed in line with the mandrel, which is the thing desired. In case no V blocks are to be had, lay the top part of the head flat on the planer bed, and shim under it with narrow strips of roofing tin, or paper,

until with the aid of a pair of inside calipers you find that the mandrel is in line with the bed.

Now, it is necessary that the bottom bearing surfaces should be, when finished, equally distant from the center of the piston-rod hole *A*, Fig. 1.

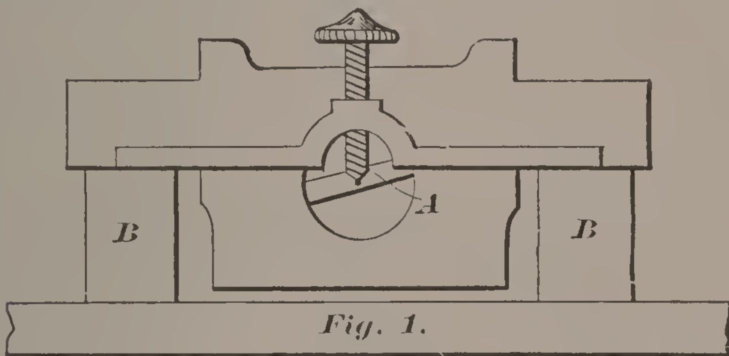


Fig. 1.

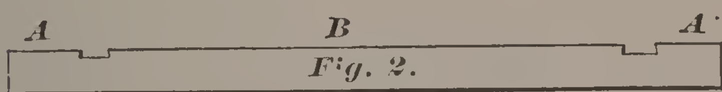


Fig. 2.

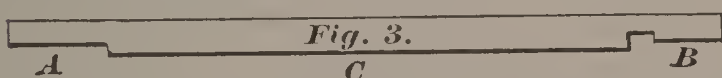


Fig. 3.

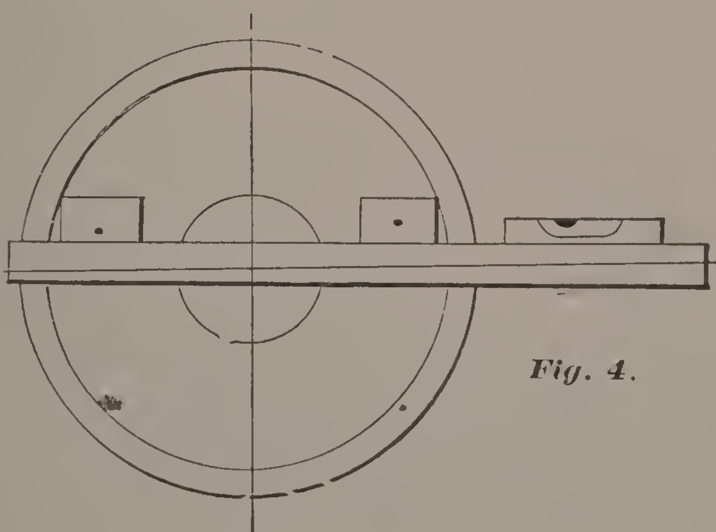


Fig. 4.

Now turn the head over, and clamp it to the bed, allowing the surfaces just finished to rest on two parallel strips of iron, *B B*. This will insure the upper and lower surface of each lug being parallel when finished. It is not necessary that the upper surface of each lug should be equally distant from center *A*, it is better to leave them an unequal thickness than to plane away the stock to make them equal; plane only enough from each upper surface to true it up.

Now the guides should be planed or ground the entire length of each, that is, when finished, the ends *A A*, Fig. 2, which bear on the guide-blocks should be in line with the wearing surface *B*. I have known some alleged mechanics who, when they wished to close guides, instead of removing and reducing the guide-blocks reduced the end of the guides as per *A B*, Fig. 3, to bring the wearing surface *C* to the crosshead. This is not the way a mechanic would do the job. Better have a liner say $\frac{3}{8}''$ thick on top of each block.

These liners can then be removed, reduced and replaced without disturbing the guides, which thereby remain standard.

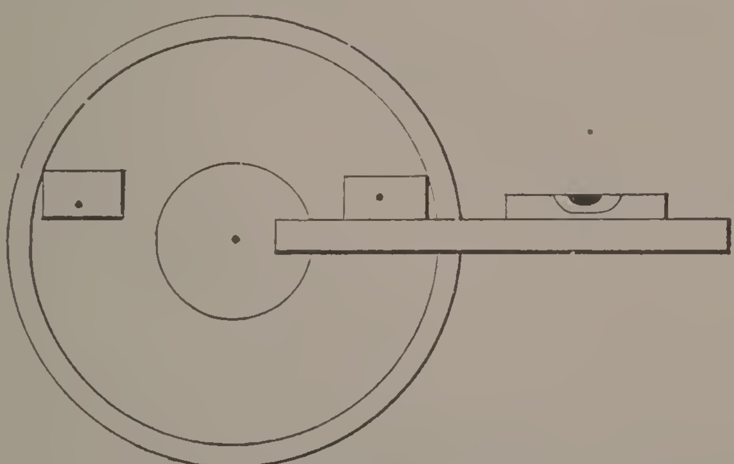
After the crosshead is trued up and the guides are ground their entire length all is ready to begin the operation of lining them up. I have taken for example that style of crosshead and guides with which ordinary eight-wheeled engines are usually equipped, for the reason that the task of properly lining up this style of guide is about as intricate as that of any other style.

Before running the line through the cylinder, care should be taken to have each guide-block in both the cylinder-head and guide-yoke perfectly level with the engine when

each is screwed solidly to place, and to obtain good results each block should be leveled *separately*. I have seen machinists endeavor to level them by placing the level on a straight-edge reaching from block to block across the head. This is poor policy, as it is impossible to level them thus, unless the distance from center to lower face of each block is equal; that is, of course, assuming that all other parts are properly constructed. The reason it is impossible to level them in the manner described when the distances mentioned are unequal is that when tightened to place, the blocks would assume the position illustrated by Fig. 4, and in this position neither the straight-edge nor either block would be level with the engine.

Therefore, I say the better plan is to level each block separately in the following manner:

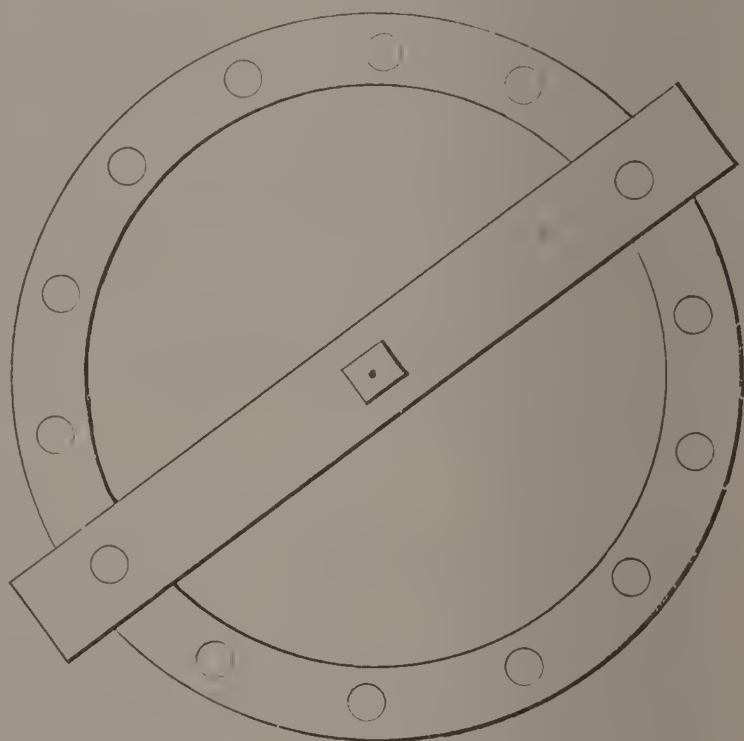
Adjust the level to a long straight-edge reaching from frame to frame just back of the cylinders, or adjust it to



that part of the cylinder upon which the steam-chest rests. Then fasten the level near the end of a shorter straight-edge, then holding the top of the other end firmly to the under surface of each block (see cut) twist them until

the level shows correct; tighten each thus and you are sure that all are level with the engine.

After leveling the blocks, take a narrow piece of board and bore an inch hole through the center; also one through each end, the proper size and distance apart to take two of the front cylinder-head studs. Over the center hole tack a small piece of thin sheet-iron, and bolt



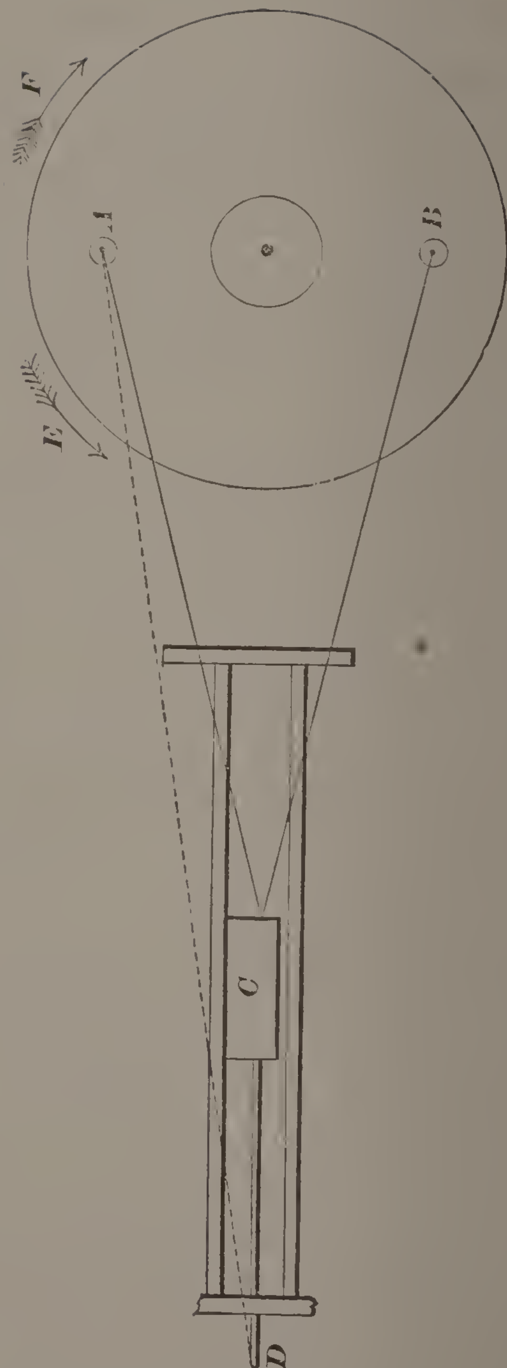
the board to the cylinder, as shown in cut. Then mark the center of the counter-bore of the cylinder on the sheet-iron, and with a breast drill bore a hole in the iron through which the line or fine wire will easily pass. After passing the end of this line through this small hole, tie a knot in it, and pass the other end through the stuffing box in

the back cylinder head, and fasten it to a stick driven tightly into the slot in the guide-yoke through which the main rod plays. This method of securing the line in the front end of the cylinder will insure its speedy readjustment should it be broken or moved from its proper place. After the line is placed as described it can be quickly brought to the center of the cylinder by the use of a pair of inside calipers.

Now get the distance from the center of the piston-rod hole in the crosshead to the lower bearing surfaces of the lugs, and compare this with the distance from the under surface of each guide-block (when in place) to the center of the line through the cylinder. Should the latter distance be the greater, then about $\frac{1}{32}''$ more than would make the distances equal should be taken from the under surface of each block. This allows for a liner $\frac{1}{32}''$ thick to be placed between each block and bottom guide when placed in their proper positions relative to the center of the cylinder. After scribing on the side of each block the amount necessary to come off, measure from the mark to the top of each, and mark on the same side, the amount necessary to make it when finished $\frac{3}{8}''$ less in thickness than is the crosshead lug.

I say $\frac{3}{8}''$ less, because, as previously mentioned, I consider it a good plan to have a $\frac{3}{8}''$ solid liner between each block and top guide, so when it becomes necessary to close the guides these liners can be slipped out and reduced the amount required, leaving each block in place. This lowers the top guides and takes up the lost motion between them and the crosshead.

When closing guides the bottom ones should never be disturbed after they are properly lined, for by so doing

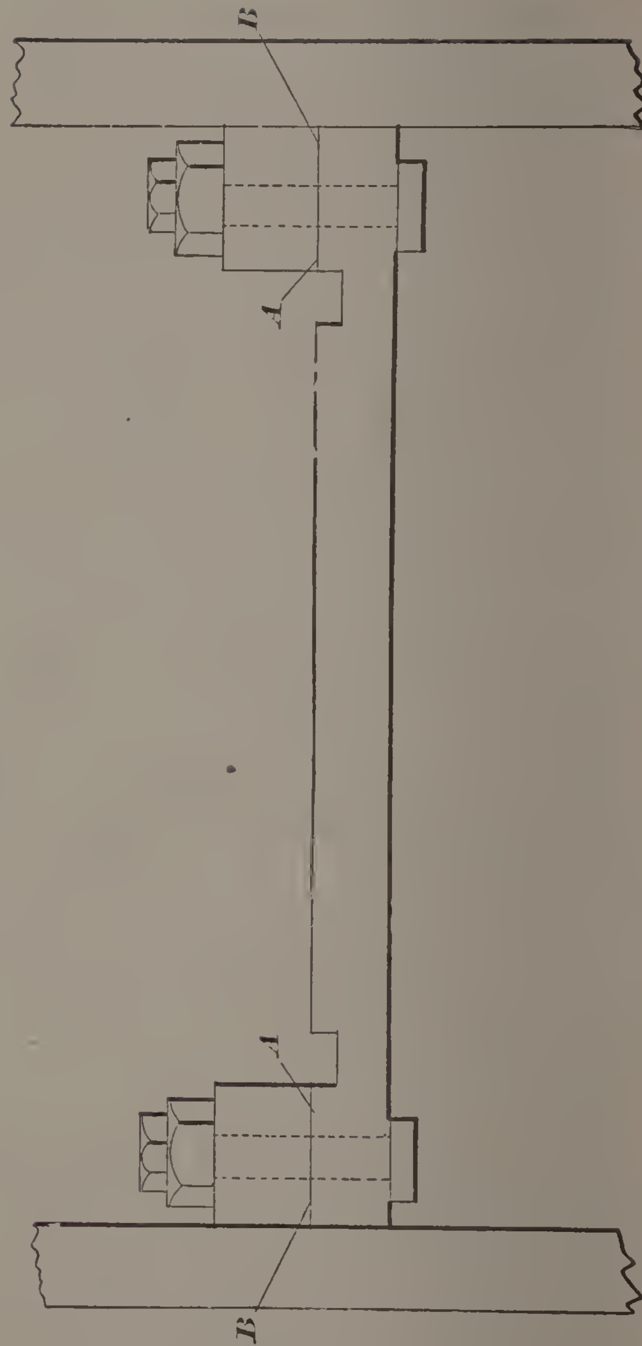

F
A
B
E
C
D

they are liable to be thrown out of line with the cylinder, and this would surely cause trouble.

Now, while an engine is using steam and running forward, the crossheads bear on the upper guides the greater part of the stroke. I will try and illustrate this.

Let *A* (cut, p. 84) represent the crank-pin on the upper quarter; *B*, the same on the lower quarter; *C*, the crosshead; *D*, the piston rod; *A* to *C* and *B* to *C*, the main rod. Now, when power is applied at *D*, to move the wheel in the direction indicated by the dart *E* (forward), the tendency is to bring the main rod, crosshead and piston rod to a straight line indicated by the dots; this pulls the crosshead against the upper guides; then when the pin reaches the point *B* and power is applied at *D*, it tends to make the angle *D C B* greater; this again pushes the crosshead to the top guides. Now, when the thing is reversed, and the wheel made to revolve in the direction indicated by dart *F* (backward), and power is applied to pin at *A*, it tends to increase the angle *D C A*, and this pushes the crossheads to the bottom guides. When the pin arrives at point *B*, applied power tends to straighten the angle *D C B*, and this pulls the crosshead to the bottom guides.

Notwithstanding that the crossheads bear on the top guides while an engine is running forward, the fact remains that the greater wear is from the bottom guides, and lower gibs, the reason for this is that the crossheads being against the top guides leaves a space between them, and the lower guides; into this space is blown dirt and grit, then when the engine is running, shut off the crossheads, drop to the bottom guides and the accumulation of dirt and grit wears away both them and the guides. This



B
A
A
B

being the case I still think it the better plan while closing guides to lower the top ones, leaving the bottom ones undisturbed for the reason stated above.

After having replaced and leveled the blocks, bolt each bottom guide to place with a $\frac{1}{32}''$ liner between it and each block, leaving the liners large enough to trim off flush with the blocks after they are in place. Put in all the bolts which are to be left in when the job is finished. Do not use temporary bolts. See that each bolt is a snug driving fit with the soft hammer. Large nuts, or a sufficient number of washers, can be used on top of the blocks in place of the top guides. After all nuts are tightened place a straight-edge lengthwise of each guide to see that tightening the nuts did not spring them. A straight-edge which reaches from oil-slot to oil-slot would be about the right length. Should a guide be high near the center, place a narrow paper liner across under the block at point *A* (cut, p. 86), at the end nearest which the high point is. Should the center of a guide show low, put the liner across at point *B*. The thickness of these liners, and whether placed at one or both ends, can only be determined by trial. After getting the guides perfectly straight, with all nuts tightened, take the short straight-edge, with level attached, and place it across the face of each guide, and see that it is level, and that the level shows correct with the engine when the straight-edge is placed across both guides. After this is done set the guide gauge so that when the beam is flush with the bottom bearing surfaces of the crosshead lugs the point will be at the center of the piston-rod hole (see Fig. 1) Now place the gauge across the faces of the guides. The point should come exactly in the center of the line or wire

its entire length. In case it does not, it must be made to do so, by either inserting or removing liners, as the case may require, being very careful not to displace the cross liners of paper put in to straighten the guides. To avoid springing them, it is best to try the straight-edges on them after every change made in the liners.

When the guides are straight, level, and in line with the cylinder, remove the line and lay the crosshead on them. Now we must see that the crosshead lies perfectly level on them at all points, or, to use a common expression, we must "take the rock out of it," and this is about the nicest part of the whole operation of lining up guides, as there is no line to guide one, and unless great care is exercised they will be thrown out of line. Very thin liners and cross liners may be removed or inserted without danger, as the crosshead will show the low points more accurately than did the straight-edges. A good way to ascertain if the guides are level is to draw heavy chalk lines across their faces at different points, for after the crosshead is passed over them they will be erased at the highest points.

When no rock of the crosshead occurs at any point, place a screw-jack under each end of the inside guide so that the bolts will just pass out; remove the bolts and put on the $\frac{3}{8}''$ liners, which, by the way, should be made exactly the size of the blocks, and the holes through them should be made large enough to admit of their sides being flush with those of the blocks when all are in their final positions. Now bolt on the top guide, which should be straightened and leveled by passing the crosshead forward and backward after the jacks are removed, and by the use of the heavy chalk lines previously mentioned.

When finished, the crosshead should pass freely from end to end of the guides, and only admit of the passage of a piece of heavy writing paper between it and the top guide.

Now with a small, very sharp chisel trim the liners flush with the blocks, and finish all with a fine file-and emery cloth. After this course of procedure is gone through with on the outer top guide no fears need be entertained in regard to the crosshead running cool, and wearing but little, provided it is made of the proper material.

In regard to the proper amount of lateral motion to allow, I will state that I have always found good results follow leaving $\frac{1}{32}''$ full. That is $\frac{1}{64}''$ full on each side.

CHAPTER XII.

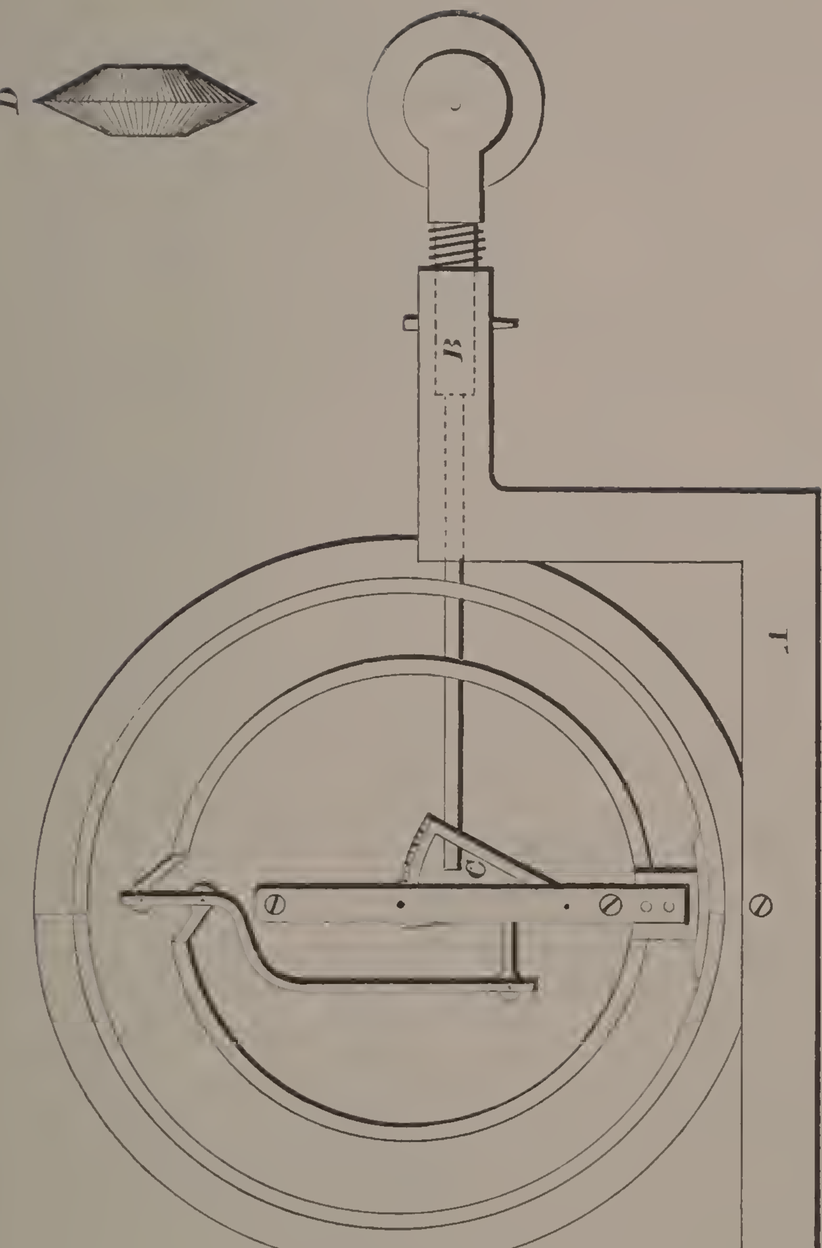
TIRE WEAR.

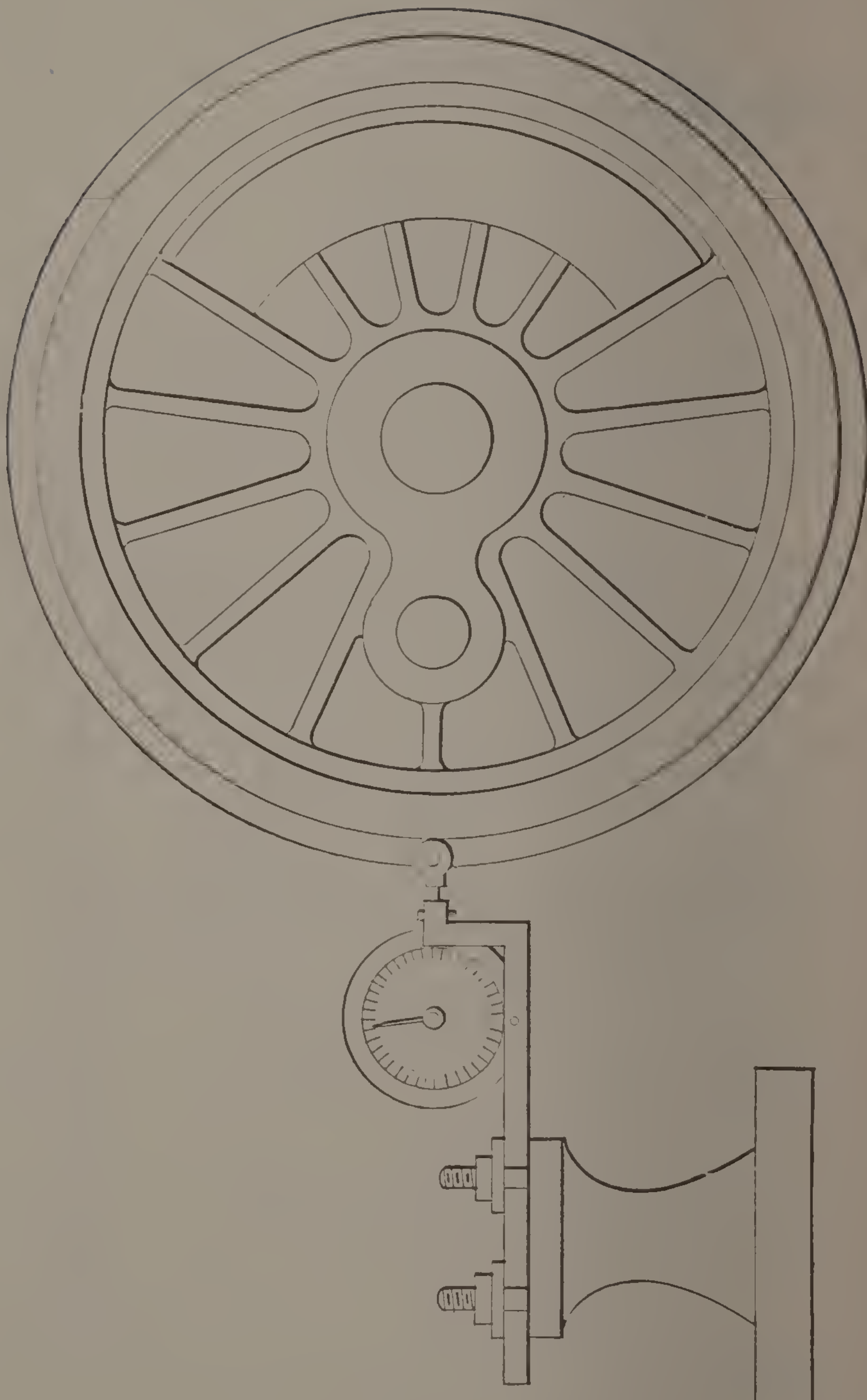
Quite an important matter to master mechanics is to know at what points on a driving-tire the greatest amount of wear occurs. One benefit derived from this knowledge is that it aids a person to determine as to whether an engine is properly counterbalanced or otherwise.

It is a well-known fact that a driving-wheel not properly counterbalanced will slip at certain points in the stroke, and a consequent wearing of the tire at these points more than at other points is the result, which, if prevented, would insure a much longer life to the tire. Then, when worn spots occur where they would not occur if caused by improper counterbalancing, it would be safe to conclude that the trouble was with the material of which the tire was made. Hence it appears conclusive that to determine the cause of tires wearing unevenly, it is necessary to correctly locate the low spots on each relative to the pin, and also to know the difference in wear from one point to another around the wearing surface of the tire.

To accomplish this object, our master mechanic, Mr. E. A. Williams, devised the following method, and employs the appliances described, obtaining very satisfactory results:

After having gotten a pair of driving-wheels into the lathe, we draw a chalk line across the wearing face of each tire at the point where a line drawn from the center


D
B
C
A



of shaft and through the center of pin would intersect the tire, and from this mark we mark off the face of each tire into thirty-six equal parts. Then marking the first line back of the pin No. 1, the second mark from pin No. 2, we number each line consecutively. No. 36 will thus fall upon the line directly opposite the pin. After numbering the lines, we place in the tool post of the lathe a gauge arranged by our machine-shop foreman, Mr. J. H. Hickman. He made a $\frac{3}{4}''$x$\frac{3}{4}''$ steel bar, *A* (cut, p. 91), and drilled the straight part to receive the steel spindle *B*, and attached the small end of this spindle to the geared quadrant *C*, in a small steam gauge. In the larger end of the spindle is cut a slot into which fits a small steel wheel about $1\frac{3}{8}''$ in diameter, whose edge is turned down thin as shown by *D*; fine teeth are then filed in the edge; a slot is then cut through the straight part of bar *A* of sufficient length to allow the hand of the gauge to make one revolution, when spindle *B* is pressed against the quadrant *C*; a small steel pin is passed through the slot, which it fits loosely, and made fast in spindle *B*; a small spiral spring is wound around the larger part of spindle, and bearing on the shoulder holds the indicator hand of gauge at *O* when no pressure is applied to small wheel in end of bar *A*. A sharp-pointed indicator was then attached to small pin in spindle *B* and the indicator hand of gauge placed at *O*; a scale was then clamped on top of bar *A* and the spindle was pushed in $\frac{1}{100}''$ and the position of indicator hand marked on gauge dial; fifty of these spaces thus indicated were then marked on the dial.

After placing this arrangement in the lathe as shown by cut, p. 92, the driving-wheel is stopped when mark No. 1

Engine No 382			
R F	*R B*	*L F*	*L B*

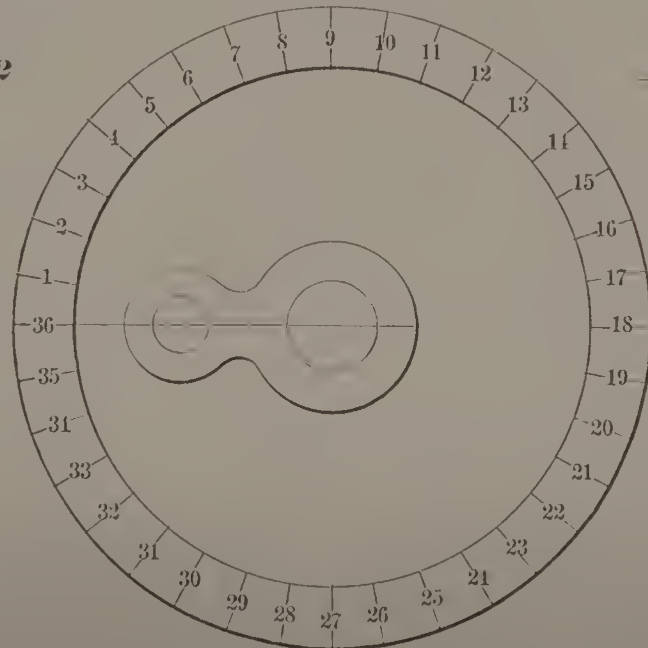
on tire is opposite small wheel in spindle. The small wheel is then pressed against the tire until the gauge hand is at No. 20. Then, as the driver revolves, mark in a column on a piece of paper each number that the

gauge indicates. The smallest number indicated is the lowest spot in the tire, and (calling the head of the column of figures No. 1) its position in the column will correspond with the number of the chalk line across the face of tire at which the low spot occurs.

Now, to correctly determine the difference in wear at the various points around the tire a chart represented by cut (p. 94) is used. (This is a rough chart made by the lathe man.) Horizontal lines divide this chart into 36 spaces, corresponding with the chalk lines across the tire. Perpendicular lines divide it into columns, one of which is used for each driving-wheel. Now the position of the smallest number in the column of figures first made is marked *O* in a corresponding position in the proper column on the chart. For instance, should the smallest number in the column be the fifteenth number from the top then the *O* is placed in space No. 15 on the chart, and the driver is revolved, and stopped when line No. 15 is opposite the gauge wheel. The gauge is then run forward until the wheel just touches the tire, but not hard enough to move the indicator hand. The lathe is then started, and as each line on tire passes under the gauge wheel the number indicated by the hand is written on the chart in the space corresponding with the number of the line passing under the gauge wheel. We thus correctly obtain the difference of wear from line to line expressed in one-hundredths of an inch.

For an office record Mr. T. A. Fogue (our engineer of tests) has a goodly number of printed charts (cut, p. 96) and when the shop foreman hands in his charts (cut, p. 94) Mr. Fogue transfers the numbers to his chart and keeps them for reference, so that at a glance one may see the

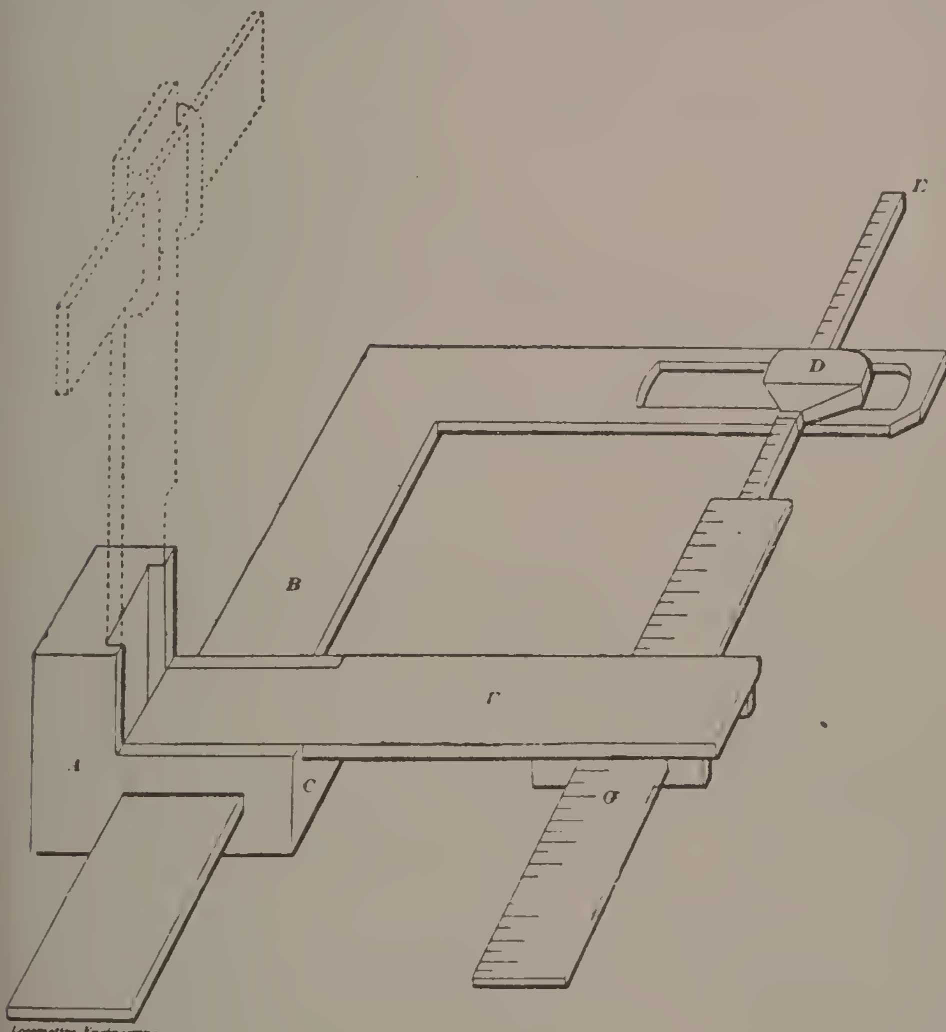
Engine No. 382 ——— *189*



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
R. F.																																				
R. B.																																				
L. F.																																				
L. B.																																				

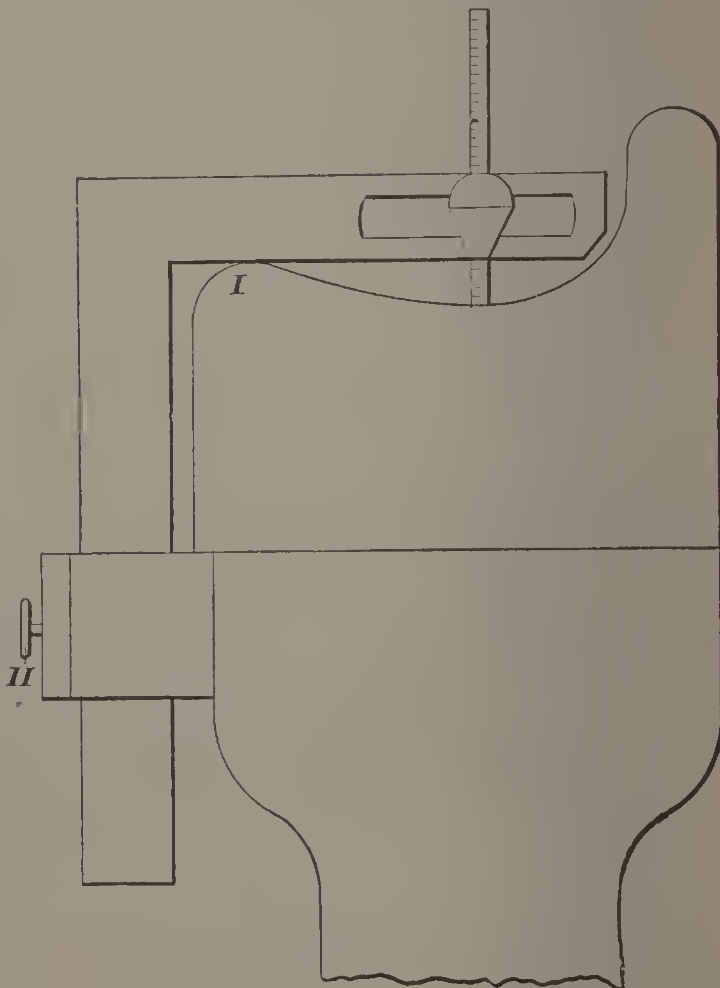
position of the low spot relative to the pin, and can also see the difference of wear between any two points.

To ascertain the thickness of the tire in the tread at point *O*, or thinnest point, I made a gauge of which the



following is a description: Take a block of brass or iron, *A* (see cut), and cut a slot in it, through which pass a square, *B*, which is held in any desired position by thumb-screw at back (not shown); the slot should be

cut about $\frac{1}{2}''$ from face *C*. This square is made of $\frac{1}{8}''$x$1''$ steel. In the top arm of the square cut a slot $\frac{1}{2}''$x$2''$, into which fit a brass piece, *D*; this piece carries a $\frac{3}{16}''$x$\frac{3}{16}''$x$4''$ scale, *E*, which passes freely through



piece *D*, when the thumb-nut at back is loosened. When the nut is tightened both the brass piece and scale are clamped firmly to the square blade. This blade is $3\frac{3}{4}''$ long, and the upright part of square is $5\frac{1}{4}''$ in

length. A square groove $\frac{1}{4}''$x$1''$ is planed in the upper surface of block *A*, into which fits a hinged piece, *F*, which is $\frac{1}{4}''$x$1\frac{3}{16}''$x$4\frac{7}{8}''$. The hinged end of this piece is left $1''$ wide, so that when it is placed in the position shown by cut (p. 97) the upper edge of it is in line with the upper surface of block *A*. The piece *F* has lugs riveted to the under side of it which forms a slot through which a $\frac{1}{8}''$x$1''$x$5\frac{1}{4}''$ scale, *G*, passes. The edge of this slot is $\frac{1}{2}''$ from end of piece *F*.

To obtain the thickness of a tire with this gauge you throw the piece *F* into the position shown by the dotted lines, and press face *C* of block *A* firmly against the turned rim of wheel center, at the same time pressing the upper edge of block *A* against that part of the tire which overlaps the wheel center (see cut, p. 98). Now loosen the thumb-screw *H*, and the square will drop through block *A* until the blade touches the tire at high point *I*. Tighten thumb-screw and loosen thumb-nut at back of square blade; this allows scale *E* to drop to wearing surface of tire. Now move brass piece *D* in the slot in blade until the end of the scale reaches the lowest point of wearing surface of tire. Then tighten the thumb-nut and remove the apparatus. Now drop piece *F* (cut, p. 97), into the position shown, and pass scale *G* upward until its upper end touches the lower end of scale *E*. The distance from block *D* indicated by lower end of scale *E* is the amount the tire is worn hollowing. The distance from upper edge of piece *F* on scale *G* is the thickness of tire at thinnest point.

Now, the gauge could have been made by leaving off piece *F* and graduating the upright part of the square. Then the difference indicated by scale and square would

be the thickness of tire. But, while finding the difference is where mistakes would be liable to occur, and I consider that the expense of putting in piece *F* is overcome by the benefit derived from having the scales show exactly the amount of wear and the thickness of tire.

CHAPTER XIII.

A TIME-SAVING WHEEL TRUCK.

To those of our readers who have many engine truck and tender truck wheels to change, the following description of a wheel truck we made here will be of interest, I think. Take a piece of sound oak plank, $2\frac{3}{4}'' \times 16'' \times 37''$; $10''$ from one end cut a hole in the center of plank, which will let pass through the top end of a common $6''$ screw jack. This hole should be cut so that the jack will stand in a perpendicular position when the plank is at the angle shown at *F*, Fig. 1. Then have forged an axle of $2'' \times 2''$ iron, bent in form of *A*, Fig. 1, turn the journals $1\frac{5}{8}'' \times 3\frac{1}{4}''$. The center part of this axle should be flattened to about $1'' \times 2''$ to admit of the bolting over it of the piece of boiler steel *B*, Fig. 1. This plate is of $\frac{3}{8}''$ steel, $8''$ wide, and bent in the form of *B*, Fig. 1. This is bolted to the bottom side of plank over the axle with $\frac{3}{4}''$ bolts, as shown at *F*. In bolting this plate to plank I used four pieces of $\frac{1}{2}'' \times 1\frac{1}{2}'' \times 12''$ iron, one of which passed over each end of the steel plate The other two pieces were let into the top side of plank flush. Each end of the steel plate takes three bolts, which also pass through the iron pieces mentioned. Then I put a $\frac{3}{4}''$ bolt through the plank and each end of the iron bars, just at the edge of the steel plate. This plate should be very securely bolted to the plank, as it carries almost the entire weight of the load. The carrying wheels shown by the dotted lines *F*, Fig. 1, are $8''$ in diameter, with $2\frac{1}{4}''$ face. The small

Fig. 1.

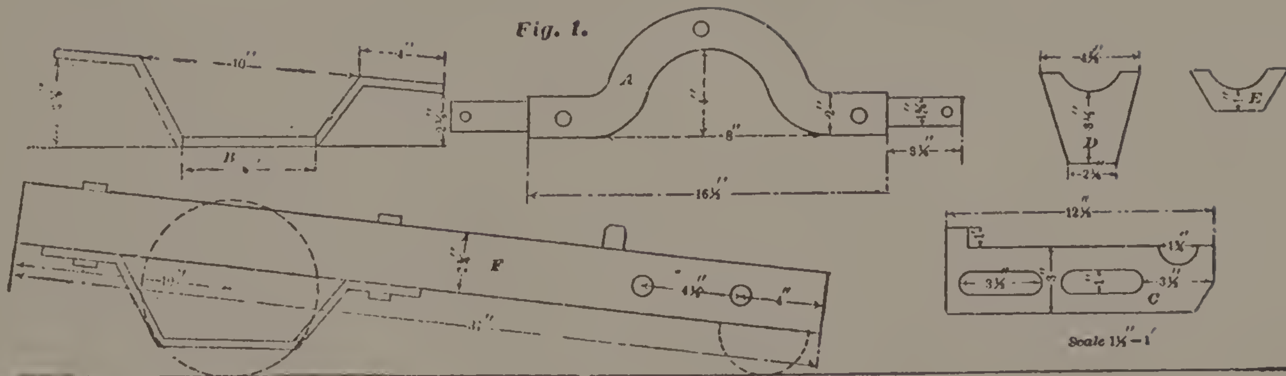
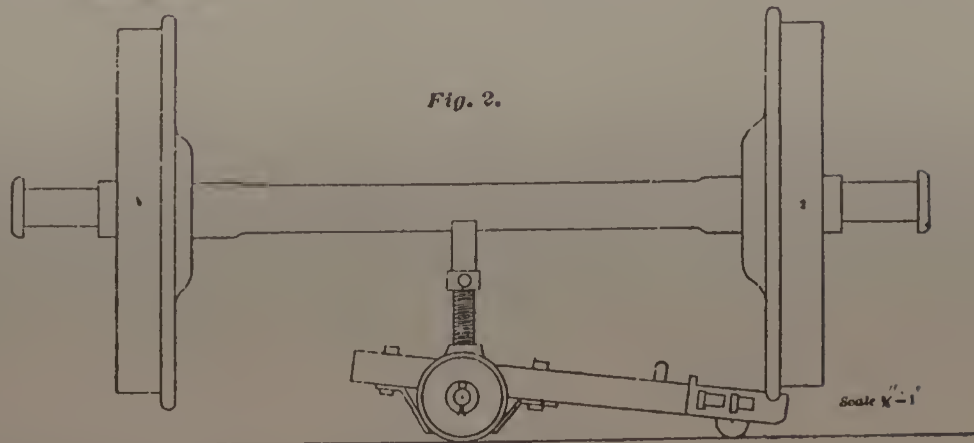


Fig. 2.



A Time-saving Wheel Truck.

lead wheel is 4″ in diameter, with $1\frac{3}{4}$″ face. This wheel is let into the center of plank near the end, as shown. For this we used a friction roller for tender truck, which had the journals cast on. For boxes we took an old pair of hand-car boxes, and bored them out to suit. Now, on each edge at the end of the plank which carries the lead wheel, I bolted a steel piece slotted as shown at *C*, Fig. 1. These were made of $\frac{1}{2}$″ x 3″ steel—made them of the broken top leaf of a driving spring—these pieces are fastened to the plank with 1″ x 5″ square-headed bolts, which pass through the slots, and screw into the plank, the same as lag screws. These steel pieces must move easily backward and forward on the bolts.

In order to have the truck carry wheels from 28″ to 33″ in diameter, I made two jack heads. The one marked *D*, Fig 1, is used when 33″ wheels are to be loaded. The one marked *E*, Fig. 1, for 28″ and 30″ wheels.

To load a pair of wheels on this truck, proceed as follows: Run the truck under the axle, and push it forward until the forward end of plank strikes the inside edge of wheel flange; this will push the ends of slotted steel pieces back flush with end of plank. Then place the jack head directly under axle, this brings the front end of the plank square with wheel flange. Then by raising jack, wheel No. 1, Fig. 2, will be raised first, for (if the truck is made to these measurements) when the truck is placed in position described above, the jack head will be 1″ nearer to wheel No. 1 than to wheel No. 2. Raise wheel No. 1 until, by pressing down on it, wheel No. 2 will be raised above the top edges of slotted steel pieces, when they can be pushed out under the flange of wheel No. 2, which (when pressure is removed from wheel No. 1) will drop

into the notches in steel pieces, and the wheels will rest in a parallel position, as shown.

We find that two men, by pushing on wheel No. 1, can run a pair of wheels thus loaded any place in the round-house.

I had two pine planks made 4″ x 14″ x 53″, and hinged them together, and faced the top sides with No. 16 sheet-iron; along the outer edges of each plank on the top I screwed a piece of $\frac{3}{8}$″ x 1″ iron, the entire length, to prevent the truck from running off. If these planks are placed across the pit and spread out, a pair of wheels can be run out and in on them nicely.

If any one of our readers will build a truck of this description and try it, I am positive that they will like it, as two men can take out and put in a pair of wheels in half the time three or four men can do it without the truck, and do it, too, without danger to themselves.

CHAPTER XIV.

A SIGNAL HOLDER.

There are many different appliances on as many different railroads for holding signal lanterns on the back end of engines and tenders, but among the many I have never seen any which exactly fills the bill, according to my notion.

Some have tin or sheet-iron boxes, with tops and two sides of each left open, in which to place the lanterns. These boxes are sometimes placed on the tender decking, one at each end of the back tool box. The trouble with these arrangements is that they are an expensive thing to make, and as two are required for each engine, this is quite an item. Then they are clumsy looking, and lanterns placed in them cannot be seen to advantage. Another objection to their use is that when they are placed on freight engines the brakemen are liable—yes almost certain—to use them as receptacles for links and pins.

In some cases these boxes are placed on top of the tender, back of the coal board, and when so placed they can be seen better, but are in the way of brakemen when they climb over the tender.

Another plan I have seen adopted is to put hooks near the top of the flare or wing of the tender, on which to hang the lanterns by the bails. The trouble with this arrangement is that the lanterns swing against and injure the paint work of the tenders, besides being very dangerous things to trainmen. I have known men to

sustain very serious injuries from being impaled on these hooks.

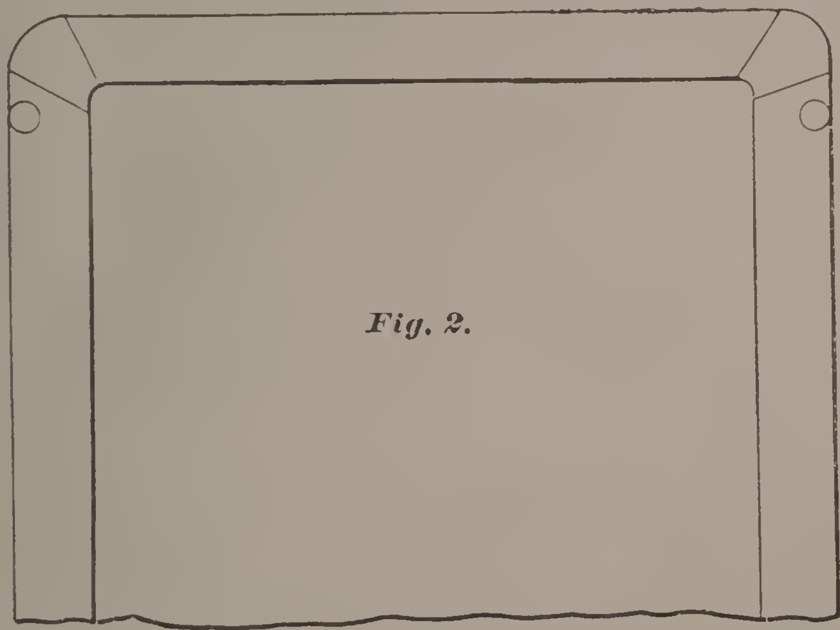
Some take blocks of wood large enough to receive the bottom of a lantern, and cut them to such a bevel that when they are placed one on each back corner of the cab roof, lanterns placed on them will stand level, the lanterns being held to place by springs or some such arrangement. This plan has its advantages over those previously mentioned, one of which is that it is more out of the way, and the lights can be easily seen; but the disadvantage is that they cannot be seen by the engineer or fireman, and are liable to be extinguished without the knowledge of either.

Not having any standard arrangement for holding signal lanterns on our engines while running light, and being required to find something which could be adopted for this purpose, I looked the field over pretty carefully, noted all of the imperfections of the appliances mentioned, and conceived the following idea, which when put into practice, proved to fill the bill better than anything I had previously seen. As it is cheaply made, and no patent on it, those who try it I think will be pleased with the results obtained.

Fig. 1.

Take two 6″ strap hinges, and cut off one side 4″ from the joint; the other end cut off 2″ from the joint; bend a hook about ½″ long on the longer end. Fig. 1 represents the hook ready to rivet to the tender. Rivet a

hook on each side of the flare (on the inside), at about the points indicated by the small circles, Fig. 2, allowing the hooks to just appear above the bead as represented



by Fig. 3. Place the lower guard wire (not the bail) of a lantern in the hook, and the lantern will stand as shown in Fig. 3, with two of the upright guards resting on the top of the bead. Our experience here has proved to us that no ordinary jar will displace the lantern from this position. The only point that the lantern touches the tender is on top of the bead, and no injury is done the paint work.

Signals in this position can always be seen by both engineer and fireman every time that they look out of the window. They can also be seen from all points in the rear of the light engine carrying them. When not in use, the hooks should be thrown down, as shown by Fig. 4.

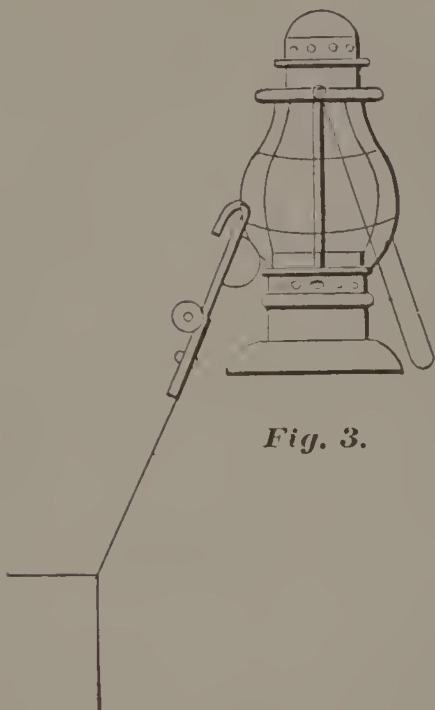


Fig. 3.

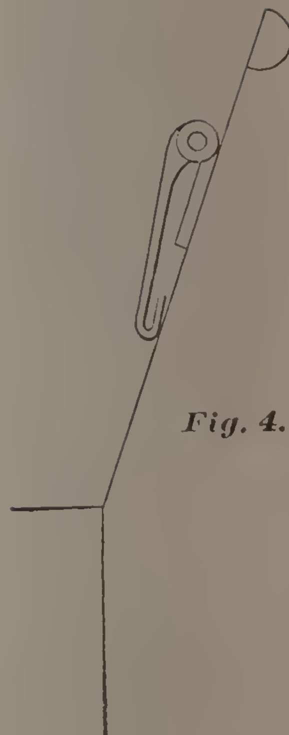


Fig. 4.

In this position they are entirely out of the way and can not be seen.

This device, we find, fills the bill in every respect. is cheap and *unornamental*